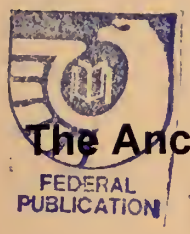

Hohokam Ecology:
The Ancient Desert People and their Environment

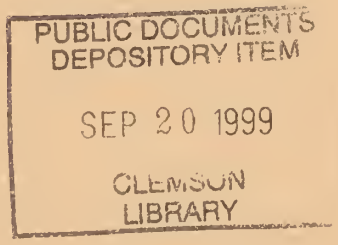

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Table of Contents

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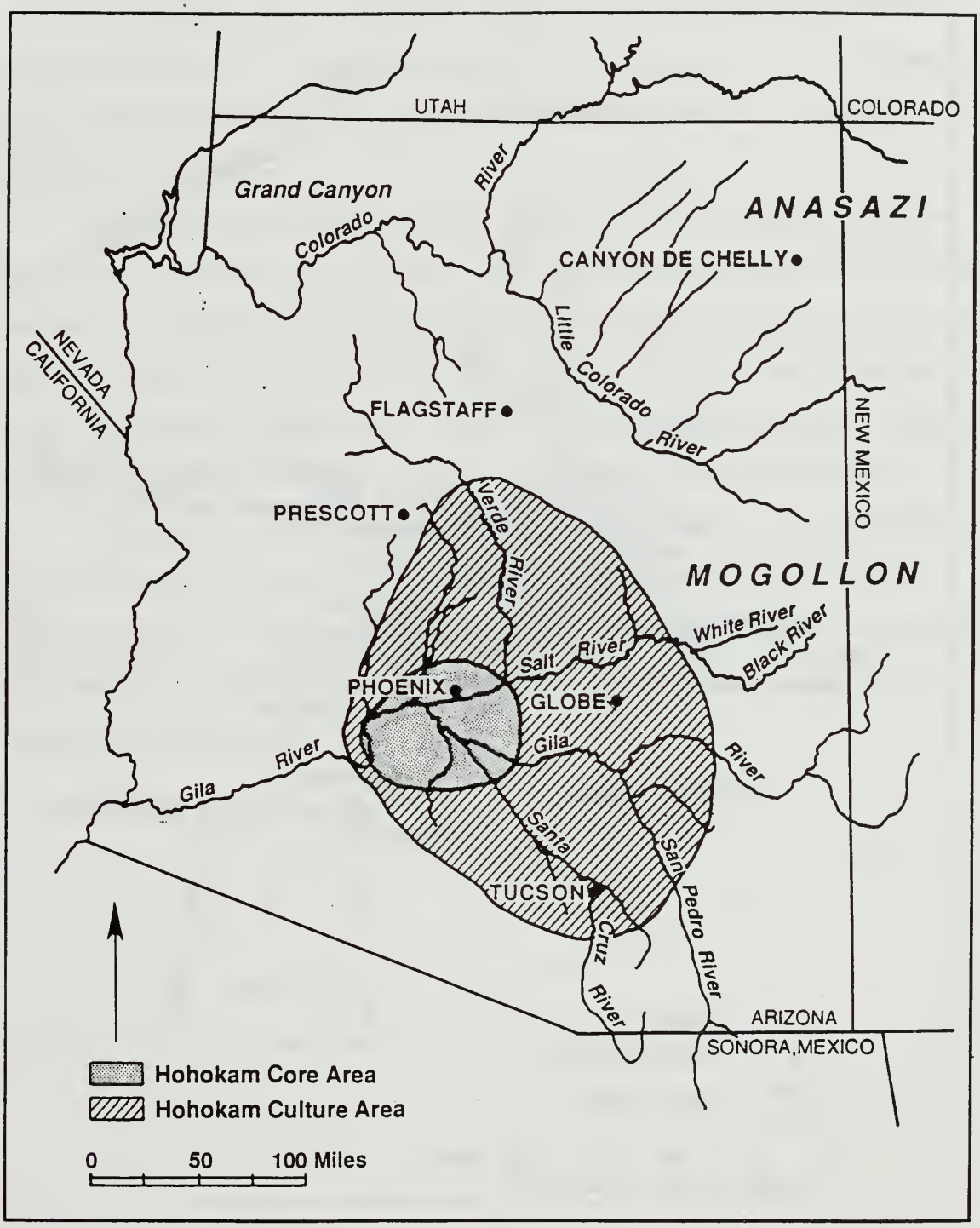
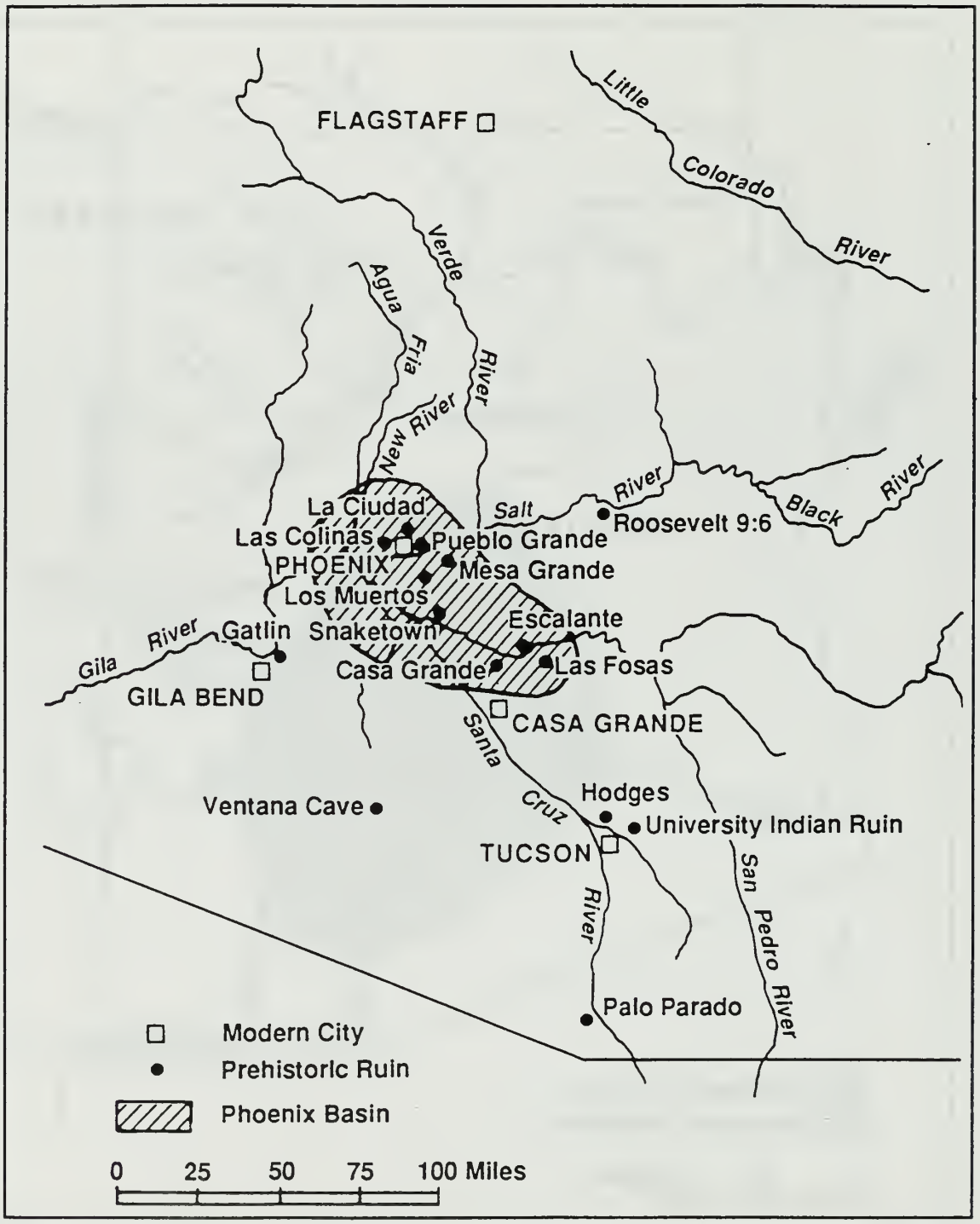
Mom, Carol Denmead, showed extreme tolerance while her daughter spent hours at her home with books and papers spread everywhere. Dad, Ted Johnson, provided encouragement and gentle reminders to finish the paper.



Arizona, showing Hohokam culture area. Map by Katrina Lasko.

From Doyel 1991b



Major Hohokam sites. Map by Katrina Lasko.

From Doyel 1991b

Preface

This paper is for the visitors and staff of Casa Grande Ruins National Monument in Coolidge, Arizona, and other Hohokam sites. My interest in biology and ecology led me to the National Park Service, and I worked as a Park Ranger at Casa Grande Ruins for four years. I noticed that the impressive, four-story Casa Grande Ruin seemed to overshadow the significance of the surrounding Hohokam environment to their culture.

"Adaptation to the environment" is a primary theme of the interpretive program at Casa Grande Ruins National Monument (Anonymous 1993:4). Staff members and volunteers rarely have time to spend searching for scientific articles on animal or plant fragments found at archaeological sites, or on the uses of plants by the Hohokam. Interpreters tend to focus their research on architecture, pottery, and other more tangible remnants of the Hohokam culture. Visitors tend to ask more questions about the most obvious Hohokam artifacts and material remains, so it makes sense to focus research efforts in that direction.

The emphasis on material remains often means that interpreters don't have enough information about the Hohokam interrelationship with their landscape. The artifacts and architecture cannot be meaningful unless woven with an understanding of the Hohokam environment. I hope that a consolidated source of basic information on Hohokam ecology will provide staff and visitors with a deeper understanding of Hohokam culture.

1
The Hohokam Environment

Descriptions of the Hohokam invariably use the word desert: Desert People, Desert Farmers and Craftsmen, Ancient People of the Desert. It is difficult to describe the prehistoric Hohokam without mentioning their desert environment, yet often we focus attention on their architecture, pottery, jewelry, and other material remains. We cannot separate the distinguishing or outstanding characteristics of the Hohokam from their desert home. The Hohokam culture is interwoven with the desert and the living things in it.

Who are the Hohokam? The Hohokam left no written language. We know about them from the things they left behind. Archaeologists define the prehistoric Hohokam culture by indicators such as: worked shell and stone, the use of pottery, irrigated agriculture, and a settled way of life. Although archaeologists still debate the chronology, current research suggests the Hohokam culture existed from sometime around AD 200 to around AD 1450 (Dean 1991:92-98).

The Hohokam are not a "tribe." Crown (1991c: 144) defined the Hohokam simply as "sedentary, pottery-producing horticulturalists." Wilcox (quoted in Gumerman 1991:7) stated that "in the prevailing view, the term Hohokam is simply a label for the phenomena of the archaeological record, i.e., the material culture, its variation, and its *relationship to the landscape* [emphasis added]."

Research shows much variation at Hohokam sites, indicating that behaviors were not consistent over the entire range of what archaeologists call the Hohokam (Gumerman 1991:20). One factor that remains consistent is the Hohokam landscape. Two elements are key determinants of the prehistoric Hohokam culture: location in the northeastern Sonoran Desert, and an elevation below 3,500 ft (1,065 m) (Fish and Nabhan 1991:30) (Map 1).

Two major Hohokam sites are open to the public: Casa Grande Ruins National Monument in Coolidge, Arizona, and Pueblo Grande in Phoenix, Arizona (Map 2). A third prehistoric village, known as Snaketown, is located on the Gila River Indian Reservation south of Phoenix. Snaketown was the site of landmark archaeological excavations in 1934 and again in 1967. Much of what we know about the Hohokam came out of the Snaketown excavations. The National Park Service administers Snaketown as Hohokam-Pima National Monument, but it is not open to the public.

The Sonoran Desert

We cannot understand the Hohokam culture out of its Sonoran Desert context. The Sonoran Desert is one of three warm deserts in the southwestern United States and northern Mexico. The Sonoran Desert covers most of southwestern Arizona and extreme southern California, as well as the Mexican peninsula of Baja California, the western portion of the state of Sonora, and the northern part of the state of Sinaloa. The Chihuahuan Desert to the east, and the Mojave Desert to the west and northwest flank the Sonoran Desert.

The three deserts are termed "warm" not only because of the annual temperatures but because precipitation falls as rain rather than snow (MacMahon 1989:232). Although highest mean temperatures occur at Death Valley, California, in the Mohave Desert, the northern Sonoran Desert is generally the hottest of North American deserts (Lowe 1985:24, MacMahon 1989:237). The upper Sonoran Desert's intermediate position between two seasonal storm tracks means that this portion of the desert receives rain in two cycles per year.

For the Hohokam, biseasonal rainfall meant something in terms of survival. MacMahon (1989:242) writes that the upper Sonoran Desert, "with its biseasonal rainfall and tropical affinities, contains a complex biota." Biseasonal rainfall correlates with high biodiversity. In the Sonoran Desert there are more than 250 native plant species that have served as food for Native Americans (Fish and Nabhan 1991:41). Greater rainfall also allows for an abundance of tree-like plants (as contrasted with shrubs in the Mojave and Chihuahua deserts). The Hohokam chose to dwell among and rely upon two of these tree-like plants in particular; the saguaro *(Carnegiea gigantea)* and the mesquite *(Prosopis* spp.*)* (Fish and Nabhan 1991:31).

Biseasonal rainfall in the upper Sonoran Desert also results in a higher percentage of ephemeral, or short-lived plants than the other deserts. Ephemeral plants mature and set seed very rapidly and thus need no chemical defenses, such as terpenes and alkaloids, that human cultures might use as medicines. This could be one explanation for the greater number of food plants over medicinal plants in the Sonoran Desert. Instead, desert ephemerals efficiently transfer much of their production into non-toxic, energy-rich seeds that the Hohokam collected for food (Fish and Nabhan 1991:42). Even in the hottest, driest parts of the Sonoran Desert, the lack of food was not so much a factor as lack of potable water (Fish and Nabhan 1991:41).

Fish and Nabhan (1991:42) write that "more than 100 Sonoran Desert plants produce edible and harvestable seeds (including grass . . . or "grains"); more than 50 species produce flesh fruit; and more than 75 species produce leaves, used primarily when immature. Roots, rhizomes, flower stalks, flowers, flower buds and stem[s] were also used by native cultures of the Sonoran Desert in prehistoric and historic times."

The Sonoran Desert home provided for the basic needs of the Hohokam, as well as inspiration for their art work. How did the land and environment evolve that became their home?

Notes on Geography and Geology

The Sonoran Desert is part of a geographic area known as the Basin and Range Province. The Rocky Mountains on the east and the Sierra Nevada on the west border the Basin and Range Province. Basin and range topography is best appreciated from an aerial view, as described by MacMahon (1989:233):

"The entire landscape is composed of rather large basins dotted with much smaller, generally north-south trending mountain ranges. . . the Mountain Ranges number more than 300. . .One worker, seeing them on a physiographic map, said they looked like "an army of caterpillars crawling northward out of Mexico.'"

The Hohokam made their home in the basins and utilized the nearby mountain ranges. What were some of the geological characteristics significant to the Hohokam?

Alluvial Fans and Bajadas. Water runoff from canyons and mountains deposits silt, sand, and rock at the mouths of canyons. An **alluvial fan** is a delta that forms at the mouth of a canyon. A **bajada** forms when silt and sand sweep down from two or more nearby canyons and join together along valleys (Shelton 1966:154).

Alluvial fans and bajadas consist of coarse-textured soil at the upper ends, with fine soil and silt sifting out at the lower ends (MacMahon 1989:233). The Hohokam collected resources from the trees, cacti, and other plants that grow in the coarse, well-drained soils of the upper bajadas. They used the productive finer soils of the lower bajadas and alluvial fans for agriculture.

Caliche. When water containing dissolved minerals boils in a tea kettle, it often leaves behind a crusty layer of calcium carbonate. A similar phenomenon occurs when water containing dissolved calcium evaporates from the soil. In desert environments, water evaporates quickly. During long dry spells, deeper moisture is drawn up through the soil and evaporates before reaching the surface. The

calcium carbonate that is left behind often cements together pebbles, sand, and other sediment forming the natural concrete called caliche.

Caliche is a type of *hardpan*, a general term that describes any compacted or cemented soil layer that is impenetrable to roots. Caliche layers can be up to 90 meters (270 feet) thick and can be at the surface or buried up to 230 meters (690 feet) in some desert valleys (MacMahon 1989:234).

Caliche comes from the Latin word *cal* for lime (Shelton 1966:240). Calcium carbonate can be mixed with other compounds to make lime for construction and agricultural purposes, but do not confuse calcium carbonate and caliche with lime (calcium oxide). The term limestone, in its loosest sense, can apply to caliche (Shelton 1966:36). However, the word limestone more correctly refers to stone consisting of calcium carbonate from the shells of marine animals such as mollusks and corals (Lambert *et al.* 1988:82).

Pottery Materials. Clay for making ceramics probably came from nearby river mud (Haury 176:191). There is no evidence that the Hohokam imported clay. The Hohokam obtained quartz and mica from local sources for use as temper (Haury 1976:212, 273).

Stoneware. The Hohokam used local stone for making hearth stones and some stone tools. Basalt, chippable stone, and fine-grained carving stones were more difficult to obtain. Doyel (1991c:230) notes that the Hohokam sought high quality stone from as far away as the New River. Because basalt for metates and other tools was hard to obtain, the Hohokam rarely discarded it. The Hohokam remodeled broken metates into other objects (Haury 1976:273). Most hammerstones were made of diorite or andesite (Haury 1976:279); most axes were made of diorite (Haury 1976:291).

The Hohokam made projectile points using chert, and quartz (Haury 1976:273, 276). According to Haury, the source of chert has not been identified, but there is a possible source in east central Arizona (1976:296). The best known source of quartz is in the Huauchuca mountains. The Hohokam also worked obsidian; the closest source of raw obsidian was near Superior, Arizona . Argillite was another resource obtainable from large outcroppings in the Mazatzal mountains (Haury 1976:277), and was used to create jewelry and carved effigy vessels (Doyel 1991c:232).

Turquoise. Turquoise is a common item at Hohokam sites. Analysis of turquoise from the Snaketown archaeological site indicates a turquoise mine near Baker, California as a source. Additional analyses indicate sources in Cerrillos, New Mexico, and in southeastern Arizona (Doyel 1991c:233).

Miscellaneous Minerals. Snaketown excavations yielded small bits and pieces of amethyst, asbestos, malachite, azurite, chrysocolla, rhodochrosite, and opal. The Hohokam may have obtained the

minerals in nearby mountains or through trade. Researchers, however, found no artifacts made from many of these minerals (Haury 1976:276). The Hohokam did not produce iron pyrite "mirrors," but obtained them from Mexico (Haury 1976:299).

Pigments. The Hohokam used hematite, a reddish brown mineral, for body decoration and pottery paint (Haury 1976:276). The identification of a source for hematite was not described in the literature.

Metals. Copper bells or crotals are the only metal found at Hohokam sites. Their source was in Mexico. The Hohokam did not produce copper (Haury 1976:278; DiPeso 1980:5).

Since the Last Ice Age: Recent Changes in the Sonoran Desert

Thomas Van Devender's (1990) studies of packrat (*Neotoma*) middens in the Sonoran Desert indicate that climate changes occurring for close to 15,000 years have changed the environment. This section is a summary of his research.

At different periods in what is now the Sonoran Desert there may have been greater rainfall and perhaps cooler temperatures caused by glacial activity further north. For example, certain plants that grow today only near washes, in the past grew on rocky slopes that today are too dry to support them. This indicates that, in the past, precipitation was greater.

Packrat Habits Reveal Climate Changes

The white-throated packrat (*Neotoma albigula*) and the desert packrat (*N. lepida*) are fond of collecting and storing trash and trinkets in piles or middens. Generations of packrats may use the same middens for thousands of years, adding discarded food scraps, urine, fecal pellets, and other "collectibles" to the pile. Their urine preserves and fossilizes any plant or animal matter in the midden.

The organic materials from packrat middens are excellent for radiocarbon dating, and samples of plant remains in the middens can represent the local flora at a given period. Scientists in the Southwest have studied packrat middens to reveal the biological changes that have occurred in the Sonoran Desert over the last 40,000 years (Van Devender 1990:134-139).

More than **11,000 years ago** a woodland dominated by pinyon (*Pinus monophylla, P. edulis, P. chihuahuensis*) and juniper (*Juniperus* spp.) trees were present, long before human beings lived in the area. There was strong summer cooling and a shift to winter precipitation. Precipitation may have been as much as 40 to 100% greater than today. However, because glaciers further north may have blocked the flow of cold arctic air, the winters were not necessarily much colder than today. The mild temperatures may have allowed for mixtures of woodland and desert plants that would seem unusual today.

From **8900 to 11,000 years ago,** the landscape was a woodland dominated by juniper, with some shrub oak and some trees that today grow only in riparian habitats (habitats close to bodies of water). The persistence of woodland trees at low elevations suggests that summer temperatures were still cooler than today. The woodland trees grew side by side with desert plants such as catclaw acacia (*Acacia greggii*) and velvet mesquite (*Prosopis velutina*)—indicating a mild climate. Junipers disappeared from the area around 8900 years ago except in small pockets.

By **4000 to 8900 years ago**, there is evidence of typical Sonoran desertscrub plants such as brittlebush (*Encelia farinosa*), saguaro (*Carnegiea gigantea*), and some riparian trees. The climate was similar to that of today, with the familiar hot summers. Many typical Sonoran Desert plants, such as organ-pipe cactus (*Stenocereus thurberi*) and chain-fruit cholla (*Opuntia fulgida*) were absent, suggesting colder winters with severe freezes. Rainfall continued to be greater than today. *Researchers find the first evidence of human beings in the Sonoran Desert from this period.*

By **4000 years ago**, relatively modern vegetation and climate existed, and the Sonoran Desert appeared then much as it does today.

Riparian Areas

Riparian areas were important to the Hohokam. What is a riparian area? The word riparian comes from the Latin *riparius*, "relating to a riverbank." Even the experts cannot agree on a definition, but they will agree that riparian areas are important to desert dwelling humans, other animals, and plants.

Smith (1988:13) describes riparian areas as "those habitats that are generally close to bodies of water, either lakes, ponds, springs or streams. They are dependent on the existence of permanent or temporary water, flowing on the surface or at least close to the surface." Some well-known Arizona riparian areas that still exist are Oak Creek, the Verde river, and Aravaipa Canyon.

Riparian areas are important because they have a richer variety of animal and plant species than the adjacent higher ground. Riparian areas were productive areas for Hohokam hunting, gathering, and agricultural activities. The Gila River and its major tributary, the Salt River, were the most important riparian areas to the Hohokam.

In 1694, Father Kino described "very large cottonwood groves. . . abundant fish" and luxurious agricultural fields and pastures along the floodplain. Beaver dams, marshes, and grasslands were abundant. Thickets of arrowweed *(Pluchea sericea),* cattail *(Typha domingensis),* and commonreed *(Phragmites communis)* grew along the banks, along with extensive bosques (forests) of mesquite trees of enormous size (Rea 1983:16).

Researchers record the highest known densities of breeding birds in the United States in desert riparian habitat. An impressive number of animals have been found in mesquite bosques — up to fifteen mammal and ninety-five bird species were found in one bosque (Nabhan 1987:71). One mesquite tree can produce a million flowers in a season. The nectar and pollen attract many animals and their predators. Up to 160 kinds of solitary bees use mesquite flowers, as do dozens of other insect species, hummingbirds, and

flycatchers (Stromberg 1993:116; Nabhan 1987:70). Bosques are prime habitat for many animals because of the nutritional quality of the available food (Stromberg 1993:117).

Most riparian habitat in the Sonoran Desert has disappeared. Dams have caused rivers to dry up and the water table to drop. The mesquite bosques and cottonwood/willow riparian forests have died off or been have replaced with exotic tamarisk *(Tamarix* spp.*),* a European introduction. In some places, such as Casa Grande Ruins National Monument, the water table has dropped dramatically. The roots of mesquite trees can no longer reach it, although mesquite roots can penetrate 175 feet into the soil.

Monument well records show that the first well dug in 1902 was 10 to16 feet deep. By 1952, the water was at a depth of 180 feet and insufficient to supply the needs of the Monument (Judd *et al.* 1971:157-8). A vast forest of mesquite skeletons and stumps has replaced the living mesquite bosque that once surrounded the Hohokam village.

According to Nature Conservancy estimates (quoted in Smith 1988:13), " . . .in the last 100 years Arizona has lost close to 90 percent of its riparian habitats." Factors leading to habitat loss include dams and diversions, erosion caused by wood cutting, livestock grazing, land clearing, and overtrapping of beaver (Stromberg 1993: 118-119; Rea 1983:3). Most of the loss has been to farms, cities, dams, and recreational development, making riparian forests very rare in North America (Smith 1988:13).

2
Hohokam Origins in the Sonoran Desert

There is evidence that people were living in the Sonoran Desert as early as 7000 BC, long before the Hohokam. They were hunter-gatherers known today as the Southwestern Archaic cultures, one of the many Archaic cultures living all over North America (Doyel 1991b:5). The Southwestern Archaic people roamed the desert in small groups. The seasons and cycles of plant and animal life probably drove their wanderings (Bartlett et al. 1986).

By 1000 BC there is evidence that small groups of these hunter-gatherers began settling into small hamlets, living in shallow pithouses made of wood, thatch and mortar. They grew corn (maize) and squash by irrigating their plots. Archaeologists call these more settled people the Cochise. The Cochise are probably the ancestors of the Hohokam (Doyel 1991b:7).

Around AD 1 some Cochise groups began moving out of the mountains and settled along the rivers. For the first time, these people emphasized farming and agriculture over foraging, probably experimented with irrigation, and began producing a plain, undecorated type of pottery. The lowland Cochise villages were double the size of their former mountain settlements. These may have been the first Hohokam (Doyel 1991b:7).

Two major rivers drain the area where the Hohokam lived, the Gila and its major tributary, the Salt. The riparian areas of the Salt and Gila rivers were important resources for hunting, gathering, and agricultural activities. The rivers appeared very different during Hohokam times, before the advent of dams and cattle. As Crown (1990:225) explains, "vegetation along the rivers formerly included large areas of riverine marshlands and groves of cottonwoods, willow, and mesquite. . ."

The origins of the Hohokam are still debated among archaeologists. Some believe the Hohokam arose out of the Cochise groups already living in the Sonoran Desert. Some believe, based on cultural similarities to prehistoric groups further south, that the Hohokam migrated from what is now Mexico. Some researchers consider a combination of the two theories, namely that a more advanced group moved in from the south and commingled with existing groups (Bartlett *et al.* 1986:18).

Visitors to archaeological sites often have questions about how people, such as the Hohokam, first arrived to an area. When interpreters discuss theories about migrations, it may be helpful to clarify the time spans involved to distinguish among the different migrations and cultures involved.

Migrations from Asia. According to Bering Land Bridge National Preserve (Anonymous 1995) around 20,000 years ago during the Pleistocene Ice Age, huge ice masses locked up much of the planet's water. Sea level was 280 to 350 feet below what it is today. The result was a continuous land mass stretching from Siberia to Alaska. This land mass was 1,000 miles wide and was more likely a grassland than a bridge of ice as often believed. Most archaeologists agree that it was across this Bering Land Bridge that humans first passed from Asia to populate the Americas.

It is possible that people may have entered North America from Asia at repeated intervals between 40,000 and 13,000 years ago. By 12,000 years ago (some 8,000 or more years before evidence of humans in the Hohokam area), artifacts suggest that people lived in parts of both North and South America. By then, waters of the Bering Strait had again become a barrier.

Migrations from Mesoamerica. The idea of a group of people migrating into the Sonoran Desert from Mesoamerica to influence the development of the Hohokam culture has long been a controversial one. Paul Kirchoff (Dow 1996) defined Mesoamerica as "the zone where a complex civilized aboriginal culture evolved in Mexico, Guatemala, and parts of Honduras." In contrast, anthropologists use the term "Middle America" to refer to all cultures south of the United States to the border of Venezuela (Dow 1996).

According to Doyel (1991a:235), recent documentation ". . .questions the position that the Hohokam were technologically advanced immigrants from Mexico . . .the Hohokam, like other major southwestern cultures, developed out of an archaic culture base." However, as Feinman (1991:465) explains, it is "difficult to ignore. . . the rather significant ideological and ceremonial traditions shared . . . by the Southwest and Mesoamerica."

If the Hohokam were not immigrants, then perhaps the Mesoamericans influenced the Hohokam through trade and exchange. Yet according to Crown (1990:245), "most exchange occurred with populations in the *immediately surrounding areas* . . .of the Hohokam domain [emphasis added]."

Beals (1974:62) describes a time when "three or four periods of expansive cultural phenomena were widespread. These seem roughly to correspond to La Venta, Teotihuacan, Tula [Toltec culture], and Aztec." He adds that "I do not wish to suggest that La Venta or Teotihuacan cultures ever spread over any important part of the Greater Southwest. . . however, disturbances and stimulation resulting from their expansion may have led to the spread of related but perhaps marginal cultures along certain avenues of the Greater Southwest to the north. . ." Haury (1977a:99) adds the Trincheras to the culture list.

In 1945, Haury (1977a:96) wrote that Mesoamerican elements did not all come from the same source, but "some are distinctly Middle American in flavor, others are matched most closely by traits in the Mexican highland cultures, and a few are from the northern fringes of the high cultures of Mexico. . .actual contact by southern traders undoubtedly existed but their influence was largely limited to the goods they carried."

There are similarities among prehistoric cultures in the Southwest and Mexico, but there are also many differences. How, then, can we explain the similarities? Feinman (1991:466) and others suggest that a "network of indirect linkages," rather than direct contact among cultures, best explains the generic nature of shared beliefs, patterns, and practices in the prehistoric Southwestern United States and Mesoamerica.

3
Hohokam Relationship to the Land

The 'Typical' Hohokam and their Lifeways

Like all human beings, the Hohokam were dependent on the land. We often describe the Hohokam people as **farmers** living in core areas near perennial rivers, such as the Salt and Gila. The farmers used **irrigation canals** and other methods of dry land farming to grow primarily **corn, beans, squash, native barley, cotton,** and **tobacco.** The Hohokam lived in villages and supplemented agriculture with **plants gathered** and **animals hunted** in the surrounding desert. They used stone and **wood** to make tools, build homes, dig canals, and to make **jewelry** and **pottery**. Each of the items in bold has biological significance that will be discussed in Chapters 4 and 5.

The O'odham Connection

Who are the O'odham, and why are they mentioned so often in literature on the Hohokam? The Hohokam were a prehistoric group, whose culture appeared around AD 200 and disappeared by around AD 1450. After 1450, there is a gap in our knowledge of people in the Sonoran Desert. When the Spanish arrived to the area in the 1600's, a group of people calling themselves O'odham ("people") lived in the areas once inhabited by the prehistoric Hohokam. A large population of O'odham still live in Phoenix and Tucson, Arizona, and on the Salt River, the Gila River, the Ak Chin, and the Tohono O'odham Indian Reservations.

The O'odham divide themselves into two regional groups. The Akimel O'odham, or "river people," live along the Salt and Gila rivers and its tributaries where the Hohokam once lived. The Tohono O'odham, or "desert people" live in the dryer, outlying areas to the southwest of the Akimel O'odham. The Spanish called the Akimel O'odham "Pima" and the Tohono O'odham "Papago."

What can we learn about the ancient Hohokam by studying modern Native American cultures? Suzanne Fish (1991:20) explains, "archaeologists are sometimes able to reconstruct prehistoric subsistence practice by observing ways in which later [Native American] groups used similar resources and environments. The [Akimel] and Tohono O'odham of southern Arizona, speakers of related Piman languages, are generally regarded as the groups most directly descended from the Hohokam."

Haury (1976:357) believed there is substantial evidence for a Hohokam to O'odham continuum. He mentions similarities in the cultures such as "the circle dance, [and] the enclosing of ritual areas with

palisades." Another piece of evidence is what Haury calls "tribal outlook toward others. . . Snaketown was not a defensive site. It enjoyed an exceptionally long life and its occupants had no over-developed weaponry. It appears that the [O'odham] reputation as a peaceful, non-aggressive people . . .has been honestly won as an inheritance from antiquity."

Haury (1976:357) also points to similar irrigation practices, the same varieties of corn, heavy use of the tepary bean, and fish-eating as evidence of continuity in "product and habit." Doyel (1991a:266-267) writes about "numerous. . . parallels. . .that link the Hohokam and O'odham," including pithouses, ramadas, public plazas, ball games, similar ceramic types, subsistence and burial practices.

The Hohokam to O'odham connection is controversial. Even Haury (1976:357) admits that his "long involvement with the Hohokam . . .and the [Akimel O'odham] leads one into the gray area of subjectivity in thinking about their kinship." Bartlett *et al.* (1986:34) write, "scientific evidence does not conclusively support one theory or the other."

Doelle (1981) has found evidence that the Akimel O'odham did not share the similarities so often reported. He notes that according to journals of Captain Manje and Father Kino, some of the Akimel O'odham did not use irrigation canals along the lower Gila, and they were more dependent on wild plants than is acknowledged (Doelle 1981:62). Rea (1983:10) writes that "when asked [by early European arrivals] about the great [Hohokam] ruins found in the Salt-Gila Valley, [the Akimel O'odham] disassociated themselves completely from them."

Haury (1976:357) states that: "to assert that there was no connection between the [Akimel O'odham] and the Hohokam requires the removal of the latter from the area by about AD 1450 and the introduction of the [Akimel O'odham] with an impressively similar lifeway almost immediately. Contacts in the sixteenth and seventeenth centuries by Europeans indicate that the [Akimel O'odham] were comfortably adjusted to their desert habitat, a 'fit' that bespeaks a long residence rather than exceptional cultural adaptability."

Even if there is controversy among scientists, among the O'odham there is little. During the excavations at Snaketown, the Akimel O'odham workers from the Gila River Indian Community became convinced that they were descendants of the Hohokam. Haury recalls then Governor of the Gila River Indian Community and Chairman of the Council, Lloyde Allison's humorous reaction to the excavations: "Allison said with a wry smile, 'I'll ask the Council to pass a resolution declaring that the [Akimel O'odham] *are* the descendants of the Hohokam' (1976:357)."

Hohokam Farming and Irrigation Ecology

There is no question that the Hohokam were skilled farmers. The Hohokam people developed basic skills of water control early. How did Hohokam irrigation and farming practices affect the environment, and vice versa?

Irrigation meant greater crop production. Major innovations in irrigation technology led to birthrate and population increase between AD 600 and 1050 (Doyel 1991:259). The canal system influenced village patterns, because the Hohokam tended to establish villages along the canals. Canals were both sources of water and a means to dispose waste. Although there is scant evidence, T. M. Fink suggested that Hohokam canals and reservoirs may have transmitted infectious diseases (Doyel 1991: 267).

Is it possible that the Hohokam were able to harvest food from the canals? According to Haury (1976:144), drying cracks in the prehistoric canals found at the Snaketown site indicate they sometimes stood empty, but they contained water over long enough periods that they sustained snail colonies and aquatic vegetation. There is no evidence that the Hohokam used either snails or aquatic vegetation from the canals as a resource.

There were no remains of fish found in the Snaketown canals, although fish are found in Hohokam trash mounds. Haury (1976:115) writes that according to scientist Stanley J. Olsen "the difficulty of catching small fish in an open stream, except under ideal conditions and with good equipment, suggests to him that the canals were the prime source [of small fishes] because the more restricted waters and fewer places for fish to hide made their capture easier."

Ecology of Hohokam Fields

One of the most obvious effects of the canals on the environment was the increased production of crop species. The Hohokam are famous for their canals, but much of Hohokam agricultural success was due to the variety of farming techniques they used other than canal irrigation. The knowledge of many farming techniques insured that if one method failed, others would produce food. Methods included locating fields on an alluvial fan, planting in areas behind check dams built across small washes, and hand-watering gardens around homes. Wells are found at some Hohokam sites. The wells may have served domestic water needs, or as Haury (1976:152) suggests, the Hohokam may have used the wells for "pot-irrigation" to water individual plants within fields.

The archaeological record provides a record of varied farming techniques as do the historic records of O'odham farming practices. According to Gasser (1981:222), historically the Akimel O'odham used diverse farming techniques to produce huge crop surpluses for use in trade.

In tending their fields, the Hohokam also created other opportunities for obtaining food. The Hohokam modified the land by digging and disturbing the soil, enhancing the habitat for weeds. Gasser (1981:223) explains that:

> "select weeds were probably encouraged in Hohokam fields or in 'second gardens' at the end of a field. Each field might have masses of amaranth, goosefoot, and other weeds along the margins and scattered among the domesticated plants. During spring weeding, the Hohokam collected young weeds for food. The plants along the field margin did not threaten to compete with the crops and were possibly left to mature, producing quantities of easily harvested seeds which were a food supply. Weeds are bountiful and . . . extremely nutritious."

In addition to encouraging weedy plants, the Hohokam removed shrubs and used them to create hedgerows around fields. They directed irrigation water to the fields that changed the natural desert vegetation. The altered habitat attracted small animals such as rabbits and quail. As Gasser (1981:222) explains: "the food potential of a field encompasses more than crops. Fields become excellent places to gather wild plants and hunt game. Such garden hunting and gathering serves a dual purpose."

Rea (1983:46) writes that historically the Akimel O'odham surrounded their agricultural fields with "fences [that] were constructed of double rows of poles thrust into the ground several meters apart, with the intervening space filled with mesquite and other spiny branches as the fields were cleared. Some trees were allowed to remain in the fields." Akimel O'odham fields and living fences "provide[d] food and cover for a high diversity of breeding and wintering birds and abundant spring and fall migrants (Rea 1983:48)." The mesquite trees, members of the legume family, may have enriched the desert soil with nitrogen. Mesquite trees accumulate this scarce nutrient more than nearly any other desert plant (Nabhan 1987:72).

Over the last thousand years, the need for the dual-purpose field has disappeared. Today the traditional field-habitats have been replaced by large-scale mechanized farming where thousands of acres are cleared and leveled and no trees or shrubs remain (Rea 1983:47).

4
Hohokam Flora

Domesticated Plants

The Hohokam grew many crops, the most prominent being corn, beans and squash. According to Emil Haury's research (1976:114), "a case can be made for maize and beans as having had the highest priority as produced foods in the minds of the Hohokam . . ."

Robert Gasser (1981:216) describes the three types of evidence used to understand Hohokam plant use:

> The first is recovery of large macroplant remains such as corn cobs, caches of seeds, or squash peduncles [stem tops] which are found during excavation . . .the second is that of flotation samples. . .the samples of earth are dumped into water and stirred. Most of the organic matter floats to the top. Flotation samples usually contain an assortment of charred and uncharred seeds, fruit parts or stem fragments. [The third type of evidence consists of] small samples of dirt. . .placed in test tubes and mixed with acids and other chemicals. . .until little remains other than a small amount of fluid containing resilient pollen and spores. Different kinds of pollen grains are [then] identified . . ."

The O'odham also provide evidence of plant use, through oral history and cultural documentation that began with European contact in the 1600's. Gasser and Kwiatkowski (1991:422) explain that "based on the historic record we should expect that ethnic and regional differentiation extended into prehistory." The O'odham grew many of the same plants as the Hohokam. Researchers find evidence of the following domesticated plants:

Corn *(Zea mays)*. Corn or maize was probably the principal food of the Hohokam. According to Gasser (1981:218), the Hohokam raised a number of insect- and drought-resistant varieties of corn. Some types of corn were so drought-resistant that they could mature with a single irrigation. Hohokam corn was different from the modern corn we know today. A variety of corn known as Onaveño was probably the most common. It has small, flinty white or yellow grains on cobs with only 10 or 12 rows. The hard grains made Onaveño corn especially resistant to insects and rodents (Gasser 1981:218).

Corn: Made in America

Native Americans began domesticating corn, or maize, as early as 5000 BC. The earliest corn was a tiny, inch-long wild corn with only 4 rows of kernels. Botanists passionately debate the origin of domestic corn, but most agree it sprang from a grass native to Mexico. Maize was unknown in Europe prior to Columbus (Rhoades 1993:100).

When Cortez arrived in Mexico in the 16th century, he found an entire Aztec cuisine based on corn. Ordinary people ate corn gruel, tortillas, and tamales. But Aztec cooks presented Moctezuma and his court, according to Spanish chroniclers, with two thousand dishes each day. Aztec connoisseurs regarded everything other than maize as a sauce or side. Fussell (1992:202) describes a variety of Aztec tamales: salted tamales, pointed tamales, white tamales, tamales with beans, spotted tamales, white fruit tamales, red fruit tamales, turkey egg tamales, green maize tamales, honey tamales, beeswax tamales, among others. Even more varied were the *tlaxcalli*, or corn tortillas (Fussell 1992:202).

The Hohokam based their cuisine on corn, and the Hohokam diet may also have been rich and varied. Corn was roasted, boiled, ground into mush, air-dried, made into hominy, added to other dishes, or ground into flour (Gasser 1981:218).

Within 100 years of the arrival of Columbus, corn had spread across Europe, Asia, and Africa. Today, corn grows in more countries than any other crop. Farmers produce enough corn to feed a billion people, but most corn is fed to cattle, pigs, and chickens (Rhoades 1993:100).

Beans (*Phaseolus* spp. and *Canavalia ensiformis*). According to Gasser (1981:218, bean remains are scarce in Hohokam sites, not because the Hohokam did not eat them, but because of the methods used to prepare and eat beans. Bean pollen grains are also rare because they are fragile. Hohokam sites reveal five species of beans: the common bean *(P. vulgaris),* scarlet runner beans *(P. coccineus)*, tepary beans *(P. acutifolius),* lima beans *(P. lunatus)* and jack beans *(Canavalia ensiformis).* The five species of beans suggest that the Hohokam used beans extensively.

Tepary Beans

The tepary bean grows wild in Arizona and parts of Mexico and was cultivated by the Hohokam and O'odham. The Tohono O'odham, called Papago by the Spanish, were and are especially fond of tepary beans. Historic documents suggest that the term 'Papago' is a condensation of *Papavi Kuadam* meaning

"tepary eaters" (Nabhan 1987:113). Other sources suggest a different origin for 'Papago,' and that the term was used mostly by "non-Indians" (Fontana 1981:35). In recent years the Tohono O'odham have rejected the "bean eater" moniker, but continue to eat and grow teparies. Today, O'odham families prepare teparies mostly for special occasions (Niethammer 1983:11).

Researchers have demonstrated the nutritional superiority of teparies over other beans in protein and mineral content (Niethammer 1983:8), yet they are still difficult to obtain commercially. Teparies are available at trading posts and stores on the Gila River and Tohono O'odham Reservations.

Teparies require soaking for at least 12 hours. It is helpful to add 1/8 tsp. of baking soda to the soaking water for each cup of dried beans. Drain the soaking water and rinse the beans. Cook with 1 teaspoon salt, a clove of garlic, 4 cups of water, and a red chile for each cup of soaked beans. Teparies will take considerably longer to cook than other varieties of beans, usually 3 hours or more (Niethammer 1983:11).

Squash and Pumpkin *(Cucurbita mixta and C. pepo).* Evidence such as pollen, seeds, or peduncles (stem tops) for squash and pumpkin use among the Hohokam is slim. What evidence exists points to only two types, *Cucurbita mixta* and *C. pepo*. The Hohokam also cultivated a third member of the squash family, the bottle-gourd *(Lagenaria siceraria),* probably for use as containers or rattles (Gasser 1981:219). Haury's (1976:302) researchers found what appeared to be a gourd rind vessel at Snaketown.

Cotton *(Gossypium* sp.*)* Gasser and Kwiatkowski's (1991:430) research shows that use of cotton was extensive in the Gila River area. Modern cotton requires a 150-185 day growing season, but the Hohokam grew a variety of cotton *(Gossypium hirsutum* var. *punctatum)* that could mature in 85 days. Not many textiles survive, but "the few available indicate great skill in weaving. Weavers created blankets, kilts, breech clouts, and sleeveless shirts for protection against the elements and personal adornment" (Crown 1991b:44)." Researchers also find cotton textiles outside the Hohokam area, but cultural neighbors of the Hohokam left no bolls or seeds in the archaeological record prior to 1100 AD. This suggests that the Hohokam traded cotton cordage and textiles before their neighbors learned to grow cotton.

The Hohokam also ate cotton seeds as food. Researchers have found parched cotton seeds at Hohokam sites. Historically, the O'odham parched cotton seeds and ate them like popcorn or pounded them into a seasoning powder (Gasser 1981:220).

Origins of Cotton

Both Old and New World human cultures independently domesticated cotton *(Gossypium sp.)*. According to Hobhouse (1985:143), in the Old World cotton may have originated in what is now Pakistan. Lewington (1991: 43) states that in the Old World, "pieces of cotton have been found in Pakistan that are 5000 years old," while in the New World, "evidence suggests one species of cotton, *G. barbadense,* was used as early as 8000 BC by the peoples of coastal Peru, and domesticated there by 2500 BC." Today, cotton is the world's most important non-food plant commodity (Lewington 1991:43).

There are thirty recognized species worldwide, all of which hybridize easily (Hobhouse 1985:146; Lewington 1991:43). Of the thirty species, only four are commercially grown. There is debate among botanists, but it appears that two of the four species were developed in the Old World *(G. arboreum* and *G. herbaceum)* and two species *(G. hirsutum* and *G. barbadense)* in the New World. According to Lewington (1991:44) the New World species have longer fibers or "staples," so it is these cottons that supply most of the world's demand. Longer staples produce a "silkier" cloth.

Pima cotton, also called Sea-island cotton or Egyptian cotton, is the same *G. barbadense* species used in Peru 10,000 years ago (Lewington 1991:44). The three different common names are a result of the crop's history. Columbus found inhabitants of the West Indies "sea islands" growing it in the 1490's. From the West Indies, *G. barbadense* was introduced to plantations in the southern United States and Egypt. By 1910 in Egypt, *G. barbadense* was a long staple, silky-fibered, luxury cotton. It was later introduced to farms in Pima County, Arizona, and became known as Pima cotton. Farmers began to produce Pima cotton for commercial use in 1916 (Nabhan 1989:59)

Pima cotton was not the same cotton (*G. hirsutum* var. *punctatum*) grown traditionally by the "Pima" (Akimel O'odham) nor the Hohokam. By the time commercial cotton production began in Arizona in 1908, the traditional crop grown by the O'odham was nearly extinct due to changes in O'odham farming practices and water shortages for irrigation (Nabhan 1989:59).

Barley *(Hordeum pusillum, Hordeum.* sp.*)*. The Hohokam may have cultivated a wild native barley plant (distinct from the Old World barley grown in Europe). Wild barley usually has a hull around the grain that is difficult to remove. Archaeologists find some hull-less barley at Hohokam sites, suggesting domestication of the wild grain (Gasser 1981:220). Grasslands covered much of southern

Arizona prior to the introduction of cattle and subsequent overgrazing. Wild native barley grasses were readily available for gathering even if the Hohokam did not cultivate them.

***Chenopodium* and *Amaranthus* species ("Cheno-ams"):** Researchers often lump members of these two weedy types of plants, known respectively as pigweed and goosefoot, into a category known as "cheno-ams." Seeds of the Cheno-ams are so common at Hohokam sites that researchers believe the Hohokam cultivated them as a staple food item. Amaranth can produce larger grain yields than corn.

In addition to archaeological evidence for seed cultivation, there is historic evidence that the O'odham gathered the young tender cheno-am greens in the spring. Amaranth greens are high in vitamin A, vitamin C, calcium, and iron (Nabhan 1987:97), and are said to have a taste resembling fresh asparagus (Nabhan 1987: 94).

Amaranth greens grew at an opportune time for the Hohokam. The greens are available during the hot summer period before Hohokam crops were ready for harvest, but at a time when their food stores from the previous year's harvest would be running low. During the mid-summer period "stored saguaro seeds, remains of last year's grains, mesquite and cultivated beans provided protein, oils and calories," but amaranth greens provided vitamins (Nabhan 1987:98). When in season, the cheno-am greens formed a major part of the diet (Gasser 1981:222).

Tobacco *(Nicotiana* sp.*)* Interpreters and archaeologists often discuss tobacco as a plant cultivated and used by the Hohokam, but according to Haury (1976:118) the archaeological record is small. Fish and Nabhan (1991:46) propose that the Hohokam used the native wild tobacco species *N. trigonophylla,* and indeed researchers have found *N. trigonophylla* seeds at Hohokam sites. The first record of a domesticated tobacco seed at a Hohokam site was *N. rustica,* found in 1983 (Bohrer 1991:231). More tobacco seeds have been found at other sites as well.

The Hohokam used tobacco, probably as "cigarettes." Crown (1991b:44) writes that "caches of ceremonial cane cigarettes, each wrapped in a miniature cotton sash, have been found in caves in the Hohokam area." Pipes are next to absent in the record (Haury 1967:118). Alternatively, the Hohokam may have placed the tobacco on censers, allowed it to burn like incense, and inhaled the smoke (Haury 1976:271).

Plants Gathered by the Hohokam

According to Gasser (1981:222), "the total number of wild plants used in Hohokam sites is impressive. In fact, many more were probably used." There are more than 250 native plant species that have served as food for Native Americans in the Sonoran Desert (Fish and Nabhan 1991:41). For comparison, we can look at the diets of the historic O'odham. The traditional Akimel O'odham diet consisted of approximately 30% gathered wild food, 60% cultivated food, and 10% hunted game. The Tohono O'odham relied even less on farming (20%), and as much as 65% of their diet came from wild plants, and 15% from hunting.

For the Hohokam, according to Haury (1976:114) "the saguaro-mesquite combination [held] the top spot among collected foods." The saguaro and mesquite were also sources of wood and other resources. A discussion of the saguaro, mesquite, and other important wild plants utilized by the Hohokam follows. Wild plants even appear in Hohokam artwork. Although the Hohokam preferred animal subjects, researchers have found a few pottery sherds painted with floral patterns (Haury 1976:237). The following paragraphs discuss some wild plants that were important to the Hohokam.

Cactus—Saguaro *(Carnegiea gigantea),* **Chollas and Prickly-Pears** *(Opuntia* spp.*),* and **Hedgehog** *(Echinocereus* spp.*).* Seeds of saguaro, prickly pear, and hedgehog cactus appear in flotation samples from Hohokam sites. Evidence for the use of cholla buds comes from pollen analysis. According to Gasser (1981:225), "cactus fruits, buds, and stems provided some essential nutrients which are not available in most native foods. All fresh cactus fruits are an excellent source of [vitamin C], and cholla buds contain significant amounts of calcium."

The Hohokam could harvest cactus foods only during brief seasonal periods. Saguaro fruit must be collected after they are ripe but before they fall from the cactus or before spoiled by birds, ants, and rodents. Cholla flower buds are best harvested in April or May before the flowers open. Gasser (1981:229) explains that "such limited availability required scheduling if the plants were to be exploited. Whole groups temporarily stopped what they were doing at home and went to preferred gathering locales to harvest saguaro fruits and cholla buds."

The Hohokam ate the ripe red fruits of the saguaro while fresh, or dried or boiled the fruit to make syrup, candy, preserves, or wine. They extracted seeds from the pulp, and parched and ground them into flour. The Hohokam ate the raw fruits of prickly-pear and hedgehog cacti after first removing the spines.

The Hohokam collected the flower buds of the cholla before the flower petals opened, as did the historic O'odham. Cholla buds are pit baked for several hours, dried, and later rehydrated for use. According to Gasser (1981:225), cholla buds have a taste and consistency similar to artichoke hearts.

Some cacti had non-food uses as well. The Hohokam used the wood "ribs" of the saguaro as support in building roofs and floors in buildings (Bartlett 1986:22; Fish 1991:25; Haury 1976:113). The O'odham used saguaro seeds to tan hides (Haury 1976:113), and Hohokam jewelry-makers used cactus spines to drill tiny holes in delicate shell beads (Crown 199b:45).

The Saguaro Cycle

The saguaro was not only a source of food, but a ritual symbol. Hodge (1991:47-48) writes that to the Tohono O'odham, June is the "month of ripening saguaro fruit," or *hashanie mashad,* which begins the traditional year. In August, families traditionally make expeditions to cactus camps. Women take one to three weeks to fell, collect, sort, and boil ripe saguaro fruit, while the men gather wood to supply the fires. Families collect 20 to 30 pounds of fruit to make 1 gallon of saguaro syrup, which the men ferment into wine. The fermentation process requires about 4 days and produces a wine with a low alcohol content (less than 5%). The height of the saguaro cycle comes with the ritual drinking of the saguaro-fruit wine.

The wine drinking ceremony has changed since the 15th century (after all, there were no pickup trucks at Hohokam ceremonies), but the purpose of the ceremony is the same. Nabhan (1982:33-38) describes one "modern" ceremony that began when "two elderly men . . .related the origins and antiquity of the wine feast. It was not simply for getting drunk, they stressed, but for bringing the rains so that the plants could grow again. . .then out of the roundhouse came young men carrying containers of wine. Each was taken to the medicine men at each cardinal point for a blessing. Each medicine man moved his fingers around the wine vessel, saying a prayer over it. He drank up a cup, then scooped up a palmful of wine and tossed it into the sky."

Nabhan discovered that vomiting was an important component of the ceremony. He "started to notice that men would stagger off from the center of the circle . . .[mostly] to throw up. . .they would turn around and come back into a circle to sing . . ."

In her pioneering work, Underhill (quoted in Nabhan 1987a:36) wrote that "the liquor had no very high alcoholic content. So much of it must be drunk before there is any intoxication that its most unusual affect is to make the drinker vomit. This is recognized as a ceremonial feature, and people say with pleasure, pointing out a man so affected: 'look, he is throwing up the clouds.'"

Saguaro wine is very unstable. It quickly changes from syrup to wine to vinegar. Even during the ceremony, some wine may already have a vinegar aftertaste. According to Dr. Andrew Weil, (quoted in Nabhan 1987a:37), the vomiting brings "instant relief and a sense of well-being." The act of vomiting also causes an invigorating increase in breathing and involuntary tears, "both of which tend to invigorate and cleanse the body." Weil adds that "there [is] a stimulation of the medulla, with a feeling of 'letting go' allowing a person 'to experience reality in another way.'" Thus, an important part of the wine ceremony is its purgative affect to the drinker, and the offering of wine (and rainclouds) to the earth.

Did the Hohokam practice a similar saguaro wine ceremony? Doyel (1991:249) describes that "a new ceremony, focusing on the production of saguaro wine, appears at a mound group at Snaketown." Masse describes "what may be saguaro wine preparation pits . . .in the Gila Valley (1991: 207)." According to Haury (1967:680) Hohokam artisans used "a weak acid solution—probably the fermented juice of the saguaro cactus fruit" to etch designs onto seashells. "Soured juice, a weak acetic acid, would have been a natural by-product of making wine from cactus fruit juice, a deeply ingrained custom among the [O'odham], and inferentially, among the Hohokam as well."

Mesquite *(Prosopis* spp.*)* According to Gasser, mesquite pod fragments are commonly the second or third most common plant remains in Hohokam flotation samples. Mesquite pods can be eaten like green beans before they are ripe, or they can be collected when mature. Other trees that produce an edible pod are ironwood (*Olneya tesota*) and palo verde (*Cercidium* spp.); however, mesquite trees produce abundant pods every year while ironwood and palo verde are less dependable food sources. The mesquite is primarily dependent on ground water that can be reached by its long tap root and is not as affected by changes in rainfall as the palo verde and ironwood.

The most important part of the mesquite pod is not the seeds, which may or may not have been eaten. Rather, it is the sweet, mealy "mesocarp" —the substance that surrounds the seeds and fills the pod. Mesquite pods are similar to a very tough cracker or shortbread cookie when they are broken in pieces. The mesquite pods are crushed and ground into "crumbs" or flour, and the seeds are sifted out. The flour can be used for many purposes. Mesquite pods are abundant, relatively easy to harvest, and nutritious.

Mesquite was also a source of wood for tools and construction. Haury's (1976:302) research located charred fragments of a mesquite wood paddle. The Hohokam used mesquite trees to frame pit houses, and to provide roof beams. Saguaro ribs and ocotillo (*Fouquieria splendens)* branches served as

lesser supports (Fish 1991:25). Reeds, cattail, grasses and brush formed the walls and roofs (Fish 1991:25; Bartlett 1986:22), topped with a layer of caliche-rich mud.

The Hohokam preferred mesquite wood for building hot fires. Mesquite wood produces more British thermal units (BTU's) of heat than the same volume of pine or juniper (Nabhan 1987:69). Mesquite wood was used for firing pottery (Fish 1991:41) and for cremating the dead. Haury (1976:166) found mesquite charcoal in cremation pits.

Agave (*Agave spp.*). Agave grows wild and the Hohokam probably gathered it in prehistoric times. However, there is abundant evidence that they may also have cultivated agave (Gasser and Kwiatkowski 1991:426-7, Swain 1987:60). Gasser and Kwiatkowski (1991:426) note that "agave appears to have provided an alternative to more extensive use of water-intensive crops such as maize." One Hohokam agave field site in Tucson was large enough to grow enough agave to provide calories for 155 persons per year. It appears that the Hohokam once planted agaves by the hundreds of thousands on the valley slopes in southern Arizona (Swain 1987:60).

A particularly well-suited agave species was *Agave murpheyi* because it reproduces "a crop of tiny plants," or bulbils, rather than setting seed. Dozens of tiny agave plant clones are borne on the flower stalks and will root within a day when placed in moist soil (Swain 1987:61). According to Swain (1987:58), to prepare agave as food, one first must find an agave that is preparing to develop a flower stalk. Agave species bloom only once in their 10-30 year lifespans, and produce flowers on a stalk that may reach 10 or 20 feet into the air. An agave preparing to bloom will have stored carbohydrates in the crown.

Once the Hohokam selected an individual agave, they removed the stiff, spiny leaves with a sharp rock until only the heart or crown remained. The leaf-less crown resembles a giant pineapple. Crowns may weigh from 5 to 100 pounds depending on the size and species of agave and are rich in carbohydrates (Swain 1987:58). The crown is traditionally baked in a pit oven for up to two days (Swain 1987:58; Niethammer 1974:3).

In Mexico, agave crowns of the species *Agave tequilana* are the source of the alcoholic drinks pulque, mescal, and tequila, but there is no evidence that the Hohokam fermented agave crowns in this way (Fish 1991:23). Not only did agave provide food, but its stiff spiny leaves also provided fiber for making string, rope, nets, and coarse cloth (Fish 1991:23). Gasser and Kwiatkowski (1991:427) state that "use of its fibers may have rivaled its food use . . .the benefits of raising agave were enormous."

Creosote-bush (*Larrea tridentata*). The fragrant desert scent after a summer thunderstorm originates with certain chemicals of the creosote-bush —vinyl and methyl ketones, camphor, and limonene.

According to Nabhan (1987: 14), "creosote-bush generates an astonishing diversity of chemicals." Many find the scent pleasant, but Nabhan (1987:14) writes that, "Sonorans call it *hediondilla*—'little stinker.'"

Creosote-bush chemicals provide the plant protection in a variety of ways. Chemical resins are found inside the plant on the leaf surface and include flavinoids, lignins, volatile oils, saponins, and waxes. Resins on leaf surfaces decrease the amount of ultraviolet light penetrating the leaf and limit the loss of water from inside. Many of these chemicals taste bad and repel insects or make the leaf indigestible. More than 360 chemicals have been isolated from the creosote-bush. Nabhan (1987:14) suggests that "it probably did not take desert cultures too long to realize that creosote [-bush]'s chemicals did more than stink—something that pungent might also be medicinally powerful."

There is no clear evidence of creosote-bush use by the Hohokam, but there is plenty of evidence among the O'odham and other desert cultures. Hundreds of medical applications for the creosote-bush have been documented over the last two centuries, including treatment of colds, chest infections, lung congestion, intestinal discomfort, stomach cramps, consumption, cancer, nausea, wounds, poisons, poor circulation, dandruff, body odor, distemper, post-nasal drip, insect or snake bites, stiff or sore feet and limbs. Plant chemist Peter Duisberg stated that creosote-bush "has been used by the [Native Americans] for the treatment of almost as many diseases as penicillin (quoted in Nabhan 1987:15)."

Scientific research shows that creosote-bush constituents may have antioxidant and fungicidal properties, and they may possibly dissolve kidney stones (Nabhan 1987:16-17). Several years ago one of its chemicals, Nordihydroguaiaretic acid (NDGA), was discussed on television as a possible breakthrough treatment for arthritis (Anonymous 1980).

Creosote-bush is not the source of the wood preservative creosote, which is derived from coal or wood tar and can be poisonous (Anonymous 1979).

Yucca (*Yucca spp.*). Yucca was a versatile plant for the Hohokam due to the tough, durable fibers in the leaves. However, products made with yucca fibers are perishable over time and the items found in the archaeological record probably do not completely reflect the variety of items made with yucca (Haury 1976:301). Yucca was twisted into cordage and woven into mats (including sleeping mats), and sandals (Haury 1976:301). Various Native American cultures have used yucca fibers to make coarse cloth, nets, brooms, and brushes (Niethammer 1974:32).

Yucca roots are high in saponin which has detergent properties. Historically, the roots were used to make soap. Niethammer (1974:29) describes that, "when pounded and soaked in water, the roots. .

.form copious suds. The suds were used for washing hair and garments, and ritually in a great many ceremonies."

Many cultures in the Southwest United States and Mexico used the yucca fruit as a food (Niethammer 1974:30), but I found no reference regarding its use by the Hohokam.

Chiles *(Capsicum* spp.)

Did the Hohokam use chiles to spice their food? Haury (1976:119) wrote that "elongated pottery dishes with rough inner surfaces provide evidence . . .that *Capsicum* or a similar 'hot' plant may have been known to the Hohokam." Haury admits that the evidence is "weak," but the elongate dishes are similar to the *molcajetes*, or chile graters, used for centuries in Mexico (1976:227). No evidence of chile plant fragments or pollen was described in the literature.

Nabhan (1987:124) writes that "although domesticated chiles were apparently not grown prehistorically north of the present day U.S./Mexico border, the little wild chiltepin [*Capsicum annuum*] was likely used for centuries in the zone from southern Arizona to the Big Bend of Texas." Wild chiltepin is classified as a tropical plant, but drought resistant relic populations can still be found in remote areas of Tohon O'odham country (Nabhan 1987:129). One population is found in a canyon near Tumacacori Mission, Arizona, and indeed, one of the mission *padres* recorded in the 1700's that Tumacacori meant "pepper bush." Nabhan (1987:130) explains that, "in archaic Papago, a little round chile would be called *aritu **tum kokorï**'* [emphasis added].

Wild chiltepines are probably the ancestors of all domesticated chiles. They are also the most powerful. Nabhan (1987:127) writes that "the chiltepin, as progenitor to most cultivated chile varieties, is the hottest mother around."

We may never be sure whether the Hohokam used chiltepines, but according to Nabhan (1987:124) the Tohono O'odham sometimes refer to it as "*I'itoi ko'okol*," suggesting that it has its place with I'itoi, Elder Brother, "at the beginning."

Miscellaneous Plants. There is pollen evidence at Hohokam sites for the use of many other plants; however, the Hohokam probably used even more plants than physical evidence indicates. How did the Hohokam use these plants?

The Hohokam probably ate four o'clock *(Nyctaginaceae),* Purslane *(Portulaca sp.),* and Horse Purslane *(Trianthema portulacastrum)* greens, and ate cattail *(Typha spp.)* shoots, roots, and catkins

(flowers) (Gasser 1981:228). Seeds of several species of grasses *(Poaceae)* were probably eaten, many have not been identifiable to species. As mentioned earlier, reeds, cattails, and grasses were also used in the construction of roofs and floors in buildings.

It is unclear for what purpose the Hohokam used the globe-mallow *(Sphaeralcea spp.),* or plants of the mustard family *(Brassicaceae)*, but at one site, archaeologists recovered a cache of over 14 million tansy mustard *(Descurainia sp.)* seeds (Gasser and Kwiatkowski 1991:437). Gasser (1981:228) writes that the Hohokam probably used the roots of the evening primrose *(Oenothera spp.)*, but he does not suggest a purpose for their use.

Plants from Far Away

Conifers: Pine *(Pinus ponderosa),* **Juniper** *(Juniperus* spp.*),* **Fir** *(Abies concolor),* and **Douglas-fir** *(Pseudotsuga menziesii).* The Hohokam carried juniper, pine, and other conifers down from the mountains for their largest structures, particularly those at important sites (Fish 1991:25). According to Wilcox and Shenk, "exotic wood" from distant places was unusual at Hohokam sites. There is some indication that the Hohokam mostly used cottonwood in construction.

Wilcox and Shenk (1977:84) identified thirteen juniper specimens, four ponderosa pine specimens, and five white fir specimens from the wood roof beams of the Casa Grande. They also identified local wood, namely one mesquite and one cottonwood *(Populus fremontii)* in the Casa Grande. Douglas-fir and ponderosa pine logs were recovered from a house at Snaketown (Haury 1976:149). Wilcox and Sternberg (1981:15) write that "the ability of the builders of the Casa Grande to amass a supply of over 500 beams of exotic wood may be highly unusual."

The Hohokam used up to 200 trees to build the roofs and floors of the Casa Grande, yet the closest sources for the wood were at least 50 miles away, in the Santa Catalina, the Superstition, and the Pinaleño Mountains. A little farther are the Huachucas, the Chiricahuas, and the Sierra Ancha ranges. The effort and possibly the expense required to obtain logs for the Casa Grande are some indication of the structure's significance to the Hohokam. How did they obtain the exotic wood?

Wilcox and Shenk (1977:87-91) examined the wood and note that it was probably not feasible to float the wood down the Gila river, as some have suggested. It appears that the Hohokam cut logs while they were still green, and there is no sign of weathering or scarring that should be found on driftwood or logs floated down a river. The Gila river is dry at places during certain times of the year, and treacherous

during others. The Hohokam either went to the source and brought the wood back, or obtained it though trade.

The Hohokam often made expeditions to obtain goods, and one or two individuals could have easily carried one or two beams the length and weight of a 12 foot two by four. There is also good evidence that the Hohokam could have obtained the beams through exchange.

Guayule (*Parthenium argentatum*). Guayule is a Chihuahua desert shrub with drab gray foliage that has been known to Chihuahuan desert inhabitants for centuries. Fish and Nabhan (1991:40) report that guayule was historically traded into the Hohokam region. According to Amsden (1974:15), in 1924 his colleague Emil Haury had the opportunity to examine a list of donated archaeological objects. The list included 'a lump of rubber, possibly a ball.' The ball was dug from a Hohokam ruin near the town of Casa Grande, Arizona, but the amateur digger did not record the circumstances.

Amsden (1974:15) described the object as "a rounded flattish lump the size of a small man's fist. The outside resembles dried clay, but underneath this crust is a hard black substance answering in every point the description of well-dried rubber."

Haury submitted the ball for analysis and found it to be rubber. The exact source of the rubber could not be determined, but Haury (1974:21) concluded that ". . .guayule would seem to be the most likely source. The properties of this plant have been known for a long time to the residents of the region where it grows, and it is not assuming too much to say that this knowledge extended well into antiquity. Certain physical qualities of the rubber in the ball suggested a guayule origin . . .but without further analysis this cannot be regarded as final."

The discovery of the rubber ball supports not only the idea that the Hohokam played some type of ball game, but that guayule was used. What technology did the Hohokam use to extract rubber from guayule foliage? Lloyd (1974:13) reports a game played in Mexico "in out of the way places" with a small resilient ball made of pure rubber. The rubber is obtained by communal chewing of the bark of the guayule.

5
Hohokam Fauna

The Hohokam Use of Animals

According to Haury's (1976:114) excavation at Snaketown, "bones of animals constitute a surprisingly small fraction of trash" compared to other Southwestern sites such as those of the Ancestral Pueblo. Haury suggests that the Hohokam were not adverse to eating meat, but perhaps animals were not readily available or the Hohokam simply preferred plant foods. Evidence discussed earlier suggests that the Hohokam diet consisted of approximately 10-15% hunted game.

Domesticated Animals

Dogs *(Canis familiaris)*. The dog was the only domesticated animal of the Hohokam. It appears that it was not common, but Haury notes that some cultures in Mexico disposed of dead dogs by throwing them in nearby rivers (Haury 1976:115). If the Hohokam also practiced this type of disposal, it would explain why dog bones are infrequent in the archaeological record. A dog cremation found at the Escalante site suggests that dogs may have been pets (Andresen 1998). According to Haury (1976:120), "there are no hints that the [domestic dog] was used as food."

Origin of the Domestic Dog

Researchers date the earliest domesticated dog *(Canis familiaris)* found in the United States to 8400 BC (Olsen 1974:344). Fossils in other parts of the world date the human-dog relationship from 10,000 to 20,000 years ago. Controversial new DNA evidence suggests that the human-dog relationship may have begun as many as 100,000 years ago (Mlot 1997:400).

Researchers for many years were not sure which canids (wolves, jackals, and/or coyotes) to give credit for ancestry of the domestic dog. New DNA evidence rules out all other canine species except the wolf *(Canis lupus)* (Mlot 1997:400). There is only one wolf species, but there are many races and variations of the wolf found around the world. Early Native Americans' dogs may have descended from the Chinese wolf race *(Canis lupus chanco)* (Olsen:1974:345).

Most modern dog breeds fall into one of four groups. The largest and most diverse group includes ancient dog breeds such as the dingo, along with modern breeds such as the collie and retriever. Other breeds such as the elkhound and German Shepherd share more genetic "DNA sequences" with

wolves—supporting the idea that dogs may have been domesticated from wolves more than once. Intense selective breeding of dogs probably began when humans began farming and herding (Mlot 1997:401).

What about the dogs that associated with Native Americans? Olsen writes that "there seems to be little doubt that when man came to North America by way of the Bering Strait, in some dim, distant past, he brought his dogs with him from somewhere in northeast Asia." According to Mlot (1997:401), "the primitive dog that hung around Native Americans all but disappeared through interbreeding with European arrivals . . .and probably wolves and coyotes." Or did it?

Olsen (1974) proposed that the Native American domestic dog may have descended from the Pariah dog, an "untamed version" of *Canis familiaris*. The Pariah dog was not a pet, a working dog, or a companion. The Pariah is somewhere on the line between the wolf and the companion dog and has distinct physical characteristics. According to Olsen (1974:345), Pariah is not a breed, but a term referring to dogs that are not attached to human households or masters: "they are not bred, reared, or protected by man but eke out a bare survival by scavenging on the food scraps that they can pick up in the alleys and streets of villages and towns." The Pariah dog has been associated with humans worldwide for centuries and "has many characteristics of a small wolf . . .that might be expected in a domesticated version of a wild dog-like canid (Olsen 1974:345)."

Wild dogs found in South Carolina have recently been recognized as a distinct breed. The Carolina dog shares characteristics with ancient breeds such as dingos and other Asian canines that may be "hallmarks of a very ancient lineage (Mlot 1997:400)." At least one scientist, I. Lehr Brisbin, Jr., suspects that the Carolina dog may be a representative or close relative of the domesticated canines that accompanied humans across the Bering Strait. Genetic analyses are now underway to try to answer the question (Mlot 1997:400).

Mammals

Hares and Rabbits (Lagomorphs). Rabbits and Hares outnumber all other animals at Snaketown (Haury 1976:114) and other sites (Gasser and Kwiatkowski 1991:444). One of the hares, the blacktail jackrabbit *(Lepus californicus),* was the most common animal species found at Snaketown (Haury 1976:114). The second most common animal was the mule deer, discussed below. The third most common species was the antelope jackrabbit *(Lepus alleni).* Cottontail rabbits *(Sylvilagus auduboni)* rank fourth (Greene and Mathews 1976:367).

Rabbit and hare populations increase around human disturbed areas such as agricultural fields (Szuter 1991:280), thus Hohokam farming activities provided crops as well as an increase in meat availability. Szuter (1991:280) suggests that animals attracted to Hohokam fields filled a niche similar to that filled by domestic animals in the Old World.

Historically, to hunt rabbits and hares Southwestern cultures used bow and arrow, rammed sticks into burrows to skewer the animal, or set traps. At times, the Hohokam performed ceremonial activities or utilized communal hunting methods (Szuter 1991:281). Historic evidence indicates that individual hunters more often took cottontails, while group-hunters captured the larger jackrabbits. Szuter (1991: 281-282) writes that in the Southwest, "the pursuit of lagomorphs was a male activity. Once killed the lagomorphs were then skinned, pulled apart, roasted or boiled and then eaten."

Deer, Sheep, and Antelope (Artiodactyls). Deer and sheep provided the most usable meat per animal (Haury 1976:114). They account for only 30% in numbers but 94% in usable meat at Snaketown (Greene and Mathews 1976:369). The mule deer *(Odocoileus hemionus)* provided most of that. Theodore White calculated that it would take 33 jackrabbits to equal the meat of one deer.

Deer are found in Hohokam artwork. Many pot sherds found at Snaketown depict deer (Haury 1976: 236). One notable pot sherd depicts a hunter directing a bow and arrow toward a deer (Haury 1976:241). At Snaketown workers found "an outstanding array of solid clay animal figurines, 19 in all, and so much alike that they could only have been made by a single craftsman." Haury interpreted the figurines as female deer, and suggested they were fertility rite objects (Haury 1976:177).

Researchers were surprised to find only 31 Bighorn Sheep *(Ovis canadensis)* at Snaketown. Haury explains that "historically the [O'odham] were heavily dependent on the Bighorn Sheep, and early writers noted enormous deposits of skulls and horns of the animal encountered in their travels." The

scarcity of Bighorn Sheep bones within Hohokam sites may be explained by these separate deposit locations. Another explanation is that Bighorn Sheep live in the mountains, and hunting them meant making special hunting trips of 15 miles or more. Gasser and Kwiatkowski (1991:445) suggest that "only high meat-yielding body parts were transported to residential sites."

Despite the lack of Bighorn Sheep bones at Hohokam sites, it was most likely an important animal to the Hohokam. As Haury (1976:114) explains, "a hint of the importance of the Bighorn to the Hohokam is seen in their art, for it was sculptured in stone, modeled in clay, carved in bone, and painted on pottery." Workers at Snaketown found a clay censer (Haury 1976:206; Crown 1991b:40) and several clay figurines (Haury 1976:268) modeled in the shape of Bighorn Sheep. Deer and sheep are also the most common animals depicted in rock art carvings (Wallace 1991: 62)

Greene and Mathews (1976:373) identified a single specimen of pronghorn antelope *(Antilocapra americana)* at Snaketown. They suggested that the Sonoran desert was not the pronghorn's preferred habitat, and only small bands could be supported. The relatively high population of Hohokam probably kept the pronghorn population in check.

Surprisingly, bone and antler were not preferred materials for art or tools. Haury (1976:305) suggests that "wood was readily available, more easily shaped and equally serviceable for the production of items like awls, skewers, picks, and musical rasps." Bone and antler products that exist are exquisitely carved and include hair ornaments incrusted with turquoise or delicately carved with miniature deer or Bighorn Sheep, carved tubes (of unknown use), rings, pendants, and a necklace (Haury 1976:302-304). Haury believes that primarily Hohokam men used the "daggerlike" bone hair ornaments, as researchers found many associated with male burials. Overall, bone and antler were unimportant materials for the Hohokam (Haury 1976:305).

Fox and Badger (Carnivores). In addition to bones of the domestic dog described above, Greene and Mathews identified bones of two other carnivores, kit fox *(Vulpes macrotis)* and badger *(Taxidea taxus)*. Compared to other southwestern sites, they found Snaketown to be "deficient in carnivore remains."

Other Mammals. Greene and Mathews (1976:369) identified packrat *(Neotoma sp.)* from Snaketown. Castetter and Bell (see Greene and Mathews 1976:369) recorded that the Tohono O'odham ate the packrat extensively during historic times. Roundtail *(Spermophilus tereticaudus)* and/or spotted *(S. spilosoma)* ground squirrels were the fifth most common animal found at Snaketown (Greene and Mathews 1976:369; Olsen 1976:378). Some of the ground squirrel bones were burned. Researchers found sixteen

other small rodents at Snaketown (Greene and Mathews 1976:369). Gasser and Kwiatkowski (1991:444) state that all rodents may not have been a resource of the Hohokam, and are "often interpreted as intrusive."

Because of the perishable nature of the materials there is not much evidence of hunting technologies used on small animals. The Hohokam may have caught rodents by using snares or traps, using stones or bows and arrows, or by direct capture from burrows (Szuter 1991:279). The animals may have been roasted on a spit with or without first removing the skin. The bones may have been consumed or discarded in the fire or trash (Szuter 1991:280). Haury (1976: 298) suggests that the Hohokam used rodent incisor teeth to chip fine serrations into stone projectile points.

Did the Hohokam utilize the mammals, such as muskrat and beaver, of the rivers and marshes? According to Haury (1976:114), "considering the dependence the Hohokam placed on a riverine environment, it is surprising that water mammals are not included in the. . . [Snaketown] list," although he notes that a 1937 excavation yielded a muskrat *(Ondatra zibethicus)*.

Birds

Native Birds. Evidence at Snaketown (Haury 1976:115) suggests that "the Hohokam made extensive use of birds and that they had developed effective means to capture them." Rea (1983:10) reports that "over a third of the Snaketown life-form [pottery] sherds depict birds, and of these about 40% are unmistakably water birds with long bills, necks and legs. Often these are shown eating reptiles or fish. Aquatic birds were clearly a conspicuous element in the Hohokam environment." Haury (1976:229) reminds us that "the bird played prominent roles in [Akimel O'odham] myths and songs, the quail, raven, hummingbird and roadrunner among them, and that four birds were [considered] the causes of diseases: the vulture, eagle, hawk, and owl."

The Hohokam along the rivers took many waterbirds. Haury states that "deep still water in the river is indicated by the presence of a diving duck [the lesser scaup] *(Aythya affinis)* and [the ruddy duck] *(Oxyura jamaicensis)."* Dabbling ducks such as the mallard *(Anas platyrhynchos)*, pintail *(A. acuta)*, and green-winged teal *(A. crecca)*, which prefer shallow water, were most numerous of the ducks at Snaketown. McKusick (1976:374) identified other waterbirds: a great blue heron *(Ardea herodias)*, a sandhill crane (probably *Grus canadensis*), a canada goose *(Branta canadensis)*, a white-fronted goose *(Anser albifrons)*, a snow goose *(Chen hyperborea)*, and an American avocet *(Recurvirostre americana)*.

Which birds did the Hohokam eat? Haury (1976:116) wrote that "it is difficult to determine which birds were eaten . . .only mockingbirds, orioles, blackbirds, and sparrows were identified in what is

presumed to be fecal remains. These are the smaller birds which could have been eaten whole, accounting for the highly fragmented nature of the bones."

In addition to meat, the Hohokam hunted birds for their feathers. McKusick (1976:374) writes that many of the geese and duck remains were bones of the wing or pectoral girdle, suggesting that "the feathers may have been valued more than or instead of the meat of the fowl." McKusick (1976:377) identified eight Hooded Orioles *(Icterus cucullatus)* and Red-winged Blackbirds *(Agelaius phoenecius)* in the size range of male birds, which have more colorful feathers. Since these specimens were found in fecal remains, the birds may have been stripped of feathers and then eaten whole. The Hohokam may have used the bright red plumage of the Cardinal *(Cardinalis cardinalis)* as well (Masse 1991:206).

Gambel's quail *(Callipepla gambelii)* is one of the most abundantly represented species from Hohokam sites. Historically the O'odham ate both the eggs and meat of the quail (Rea 1983:139). Gambel's Quail is frequently depicted on Hohokam pottery (Haury 1976:230). Haury identifies other pottery paintings as hummingbirds (230), a cormorant (231), a pelican (232), a duck (232) and other water birds.

Researchers found numerous yellow-feathered birds at Snaketown including a yellow-headed blackbird *(Xanthocephalus xanthocephalus),* a meadowlark *(Sturnella sp.)*, a gilded flicker *(Colaptes auratus),* and hooded orioles (McKusick 1976:377). The Hohokam seem to have preferred yellow feathers, although Rea (1983:241) reexamined the reputed oriole bones and said they were too fragmented to be identified. The Hohokam also hunted hawks for feathers. McKusick identified bones of a coopers hawk *(Accipiter cooperii),* a swainson's hawk *(Buteo swainsoni),* marsh hawks *(Circus cyaneus),* and a sparrow hawk *(Falco sparvarius).* Researchers found only hawk and falcon pectoral girdle and wing bones, and these were in the size range of females. McKusick suggests that the Hohokam preferred the banded feathers of female hawks and falcons over the uniformly colored male feathers. Birds inspired artwork: elaborate shell and turquoise mosaic pendants depict raptor birds (Haury 1976: 312; Wilcox 1991:58)

Other birds identified from Hohokam sites include roadrunner *(Geococcyx californianus),* scrub jay *(Aphelocoma coerulescens),* raven *(Corvus corax),* mourning dove *(Zenaidura macroura),* and dark-eyed junco *(Junco hyemalis)* (McKusick 1976:377).

Exotic Birds. The turkey apparently was not an important animal to the Hohokam. Some prehistoric groups in the Southwest, most notably the Ancestral Pueblo, domesticated the turkey. The turkey was probably raised for the feathers even more than for the meat (Cordell 1984:34; Rea 1983:140;

Nabhan 1989:156-174). Haury (1976:116) notes that the original Snaketown excavation yielded the remains of one turkey, but writes that "the bird was extremely scarce at best, and there is no basis for believing that the Hohokam domesticated or even kept it."

Rea (1983:140) writes that the turkey specimen from Snaketown has been lost and cannot be verified, however he did identify one small turkey from another site. Rea echoes Haury's conclusion by writing that "the Hohokam must not have regularly kept domestic turkey, as evidenced by the almost total absence of turkey bones from their sites."

McKusick identified scarlet macaws *(Ara macao),* an unidentified macaw *(Ara spp.),* and a thick-billed parrot *(Rhynchopsitta pachyrhyncha)* from Snaketown. Rea (1983:163) identified scarlet macaws from Pueblo Grande and Las Colinas sites. Parrots may have occasionally wandered along the Salt and Gila rivers, while scarlet macaws are found in southern Mexico (Rea 1983: 163). The Hohokam imported macaws from Mesoamerica, and probably parrots as well, for their bright plumage. The Hohokam may have begun importing the birds as early as 100 AD.

The Hohokam may have respected or revered the tropical birds, as they are frequently found as burials (Haury 1976: 116). Parrots are also depicted in pottery paintings. One pottery design depicts human "burden bearers" that have often been interpreted as traders. Birds are painted among the burden carriers. Haury (1976:239) suggests that the design may depict the method used to transport the exotic birds.

Prehistoric Trade

The Casas Grandes archaeological site (*not* Casa Grande Ruins) in Chihuahua, Mexico, may have been the northern trade outpost for "an advanced civilization to the south," possibly the Toltecs of central Mexico or the Tarascan empire of western Mexico. DiPeso (1980:4) compares this outpost to the Hudson Bay Company that represented the interests of Great Britain in North America in the 17th and 18th centuries. While the Hudson Bay Company sought furs, DiPeso's hypothesis suggests that Casa Grande traders sought turquoise (1980: 8). Turquoise could be found in 27 mines in the southwestern United States, most of which were exploited prehistorically (Haury 1976:278). Turquoise was traded from what is now the southwestern U. S. as far south as Central Mexico (Doyel 1991b:7).

The Casas Grandes traders knew their market. To obtain turquoise, they brought marine shells, macaws, parrots, and copper bells (crotals). Excavators at Casas Grandes have found millions of shells warehoused at Casas Grandes. Evidence that the site was a breeding center for Scarlet Macaws is found in remains of adobe hutches with roosting holes, eggshell remains, and remains of birds as young as two weeks old (DiPeso 1980:8).

Not all credit for trading practices can be given to so-called advanced civilizations to the south. Doyel (1991c:226) writes that "the Hohokam initiated, maintained, and regulated numerous corridors of commerce. . ." Hohokam worked shell was traded as far north as the Mogollon and Ancestral Pueblo areas (Crown 1990:245).

Reptiles. Olsen (1976: 378) identified bones of lizards and non-poisonous snakes from Snaketown, but the bone fragments were too small to identify to species or genera. Minckley (1976: 379) identified a shell fragment of a native turtle, genus *Kinosternon.* Haury (1976:115) states that the snake and lizard bones were found with the remains of other food animals, and so the Hohokam probably ate them as food. Olsen (1976:378) found at least one burned snake bone sample, possibly burned during meal preparation.

Haury (1976:115) notes that researchers at Snaketown found no poisonous snakes or Gila Monsters in the archaeological record. He suggests that the poisonous reptiles may have been avoided not only because of their dangerous venom, but "because of their association with the spirit world, hinted by frequent depictions in Hohokam art." Snakes portrayed in Hohokam art are always rattlesnakes (Haury 1976:185). The Snaketown excavation yielded many reptilian figures (Haury 1976:175-321): snakes are

carved into container handles (Haury 1976:186) and coiled in clay to form a bowl (Haury 1976:206). One pottery design depicts a snake being attacked by a series of birds, possibly roadrunners (Haury 1976:232).

Lizards were an important Hohokam subject. The lizard is the only animal that appears in every type of Hohokam artwork, from ceramics, to shell jewelry, to stone bowls, to slate palettes (Wilcox 1991:53). Horned lizards (*Phrynosoma spp.)* are found in sculpture (Haury 1976:188), shaped into censers (Wilcox 1991:54), and carved on stone bowls so that they seem to peer over the rim (Haury 1976:186). A bowl sherd from Snaketown shows a lizard encircled by dancers, and an oft-photographed human effigy jar wears a lizard pendant around its neck (Wilcox 1991: 53). Turtles and geckos are other common reptilian subjects on Hohokam pottery. Lizard forms painted with dots may represent Gila Monsters *(Heloderma suspectum)* (Haury 1976:234-235).

Amphibians. Very little mention was found in the literature regarding amphibian remains at Hohokam sites. McKusick (1976:374), who identified the bird remains from Snaketown, notes "an unusually large proportion of fish, amphibian, reptile and arthropod remains" were mixed in the cupful of bone specimens that she sorted. Apparently no attempt was made to identify the amphibian remains, but McKusick was left with "an impression that the Hohokam utilized almost anything that moved."

Amphibians are found in Hohokam art, indicating that they played a role in Hohokam life. According to Haury (1976:186) the Snaketown excavation uncovered a censer with a "snake in the act of catching a frog," another with a "triad of frogs in relief" (1976:184), and a medicine cup with an image of a toad (Haury 1967:693). Elaborate shell and turquoise mosaics depicted toads (Wilcox 1991:58). Rea (1983:10) reports pottery sherds depicting waterbirds eating frogs.

Fishes. Research at Snaketown provides evidence that the Hohokam ate fish, but as a small fraction of the diet. The Hohokam caught fish of all sizes and ate them raw, boiled, roasted, or dried. Haury suggests that the Hohokam may have harvested smaller fishes from the canals (1976:115). Fish may have been netted or hand caught. There is no evidence of fish hooks or other fishing gear (Haury 1976:119).

The most common fishes, in order, were Sonoran sucker and desert suckers *(Catostomus insignis* and *Pantosteus clarki),* the roundtail chub *(Gila robusta),* razorback sucker *(Xyrauchen texanus)* and Colorado squawfish *(Ptychocheilus lucius)* (Minckley 1976:379). Many of these fish species are threatened. The Colorado Squawfish is on the federal list of endangered species (Gallizioli 1979:62).

Researchers at Snaketown also found remains of marine fishes. Minckley (1976:379) identified earbones (otoliths) of drums or croakers, one of which appears to be of the genus *Cynoscion*. Otoliths are shell-like and were probably used as ornaments.

Invertebrates. Except for worked shells, there is little discussion of invertebrates in the Hohokam environment. What evidence is available indicates that the Hohokam made use of a variety of invertebrate animals. Invertebrate animals also may have negatively impacted the Hohokam in a variety of ways. Invertebrate groups relevant to the Hohokam are mollusks and arthropods.

Mollusks. Haury suggests that the Hohokam collected and ate the fresh water clam *(Anadonta dejecta)* prevalent in the Gila River. The Hohokam used fresh water clam shells to make ornaments (Haury 1976:374); however, marine shells from the Gulf of California were the primary raw material for decorative ornaments and jewelry. Hohokam shell artisans carved shells into bracelets, beads, and rings. They carved shell pendants in a variety of animal shapes (Haury 1976:312). They also used shells as scoops and paint containers. It appears that the Hohokam did not seek marine shells as a source of food.

The bivalves *Glycymeris gigantea, G. maculata,* and *Laevicardium elatum,* comprise a large proportion of delicately worked Hohokam shell beads, rings, and pendants. Shell crafters easily carved small univalves such as *Olivella spp.* into beads (Haury 1976:305-321). Haury (1976:307) lists multiple freshwater and marine shells identified to species and/or genus from Snaketown (Appendix II).

In addition to carved shell, the Hohokam were unique in the development of acid etching of shell designs. Acid etching was accomplished by applying a wax or pitch to the area of the shell to be protected. They soaked the shell in a weak acid that gradually dissolved the calcium carbonate of the shell, leaving a raised design under the pitch. The pitch was then scraped away to reveal the design. It is very likely that the Hohokam used soured saguaro wine (vinegar) as the acid (Haury 1976:318).

Shell jewelry was probably an important Hohokam export item. Haury (1976:305) writes that "the Hohokam have frequently been characterized as the. . .shell merchants of the Southwest." Hohokam shell products have been found as far away as New Mexico (Haury 1976:321).

Arthropods. McKusick notes that she found unidentified arthropod remains among other bones of presumed food animals (1976:374). Masse (1991:208) notes sphinx moth larvae as a food source. The importance of most arthropods, however, was not as a food source. Scorpions are often depicted in pottery art (Haury 1976: 236). Unidentifiable insects appear in both pottery paintings (Haury 1976:236, 240) and rock art (Wallace 1991:62). Identifiable insects in rock art include ticks or mites and dragonflies. The

familiar southwestern flute-player symbol seen in prehistoric art sometimes takes the form of an insect (Haury 1976:240).

Prehistoric insects probably caused damage as they do today. Bartlett (1986:22) writes that "termites or infestations of other insects often caused the destruction or abandonment of [Hohokam pit houses]." Insects probably caused crop damage as well. Although the Hohokam grew insect resistant Onaveño corn, they may have had infestations of aphids and corn earworm *(Heliothus* spp.*)* as Southwestern farmers do today. *Heliothus*, also known as cotton bollworm, feeds on cotton crops (Butler 1995). The boll weevil and the bollworm that affect cotton crops today is a recent introduction.

A beneficial insect was the cochineal *(Dactylopius* spp.*),* which feeds and lives on the prickly pear cactus. The cochineal insect contains a red fluid called carminic acid, a color-fast natural dye. The Akimel O'odham used cochineal to dye the ends of war arrows (Crosswhite 1984:64). In historic times there was a worldwide demand for cochineal to dye fabrics, but there is no prehistoric evidence for its use as a fabric dye. Cochineal is still used today as coloring in processed foods and fruit drinks. Other insects were essential as pollinators and predators on crop pests as they are today.

A marine arthropod is also represented in the archaeological record. Haury (1976:116) notes that Snaketown produced the pincer claw of a marine swimming crab, probably *Callinectes bellicosus* from the Gulf of California. Haury suggests that the item provides evidence that the Hohokam made the trek to the Gulf personally, since the pincer claw was probably brought home as a "souvenir." It is not likely that it was a trade item (Haury 1976:116).

Conspicuous by their Absence

Four species of animal associated with the southwestern U. S. are not found at Hohokam sites: the Javelina or collared peccary*(Tayassu tajacu)*, the coyote *(Canis latrans),* the horse *(Equus caballus)*, and cattle *(Bos taurus)*.

Cattle. The first cattle in North America arrived to Hispaniola in 1493 with Columbus' second voyage (Rouse 1977:21). According to Jordan (1993:), "longhorn imports to the Indies continued from 1493 to 1512. . .all of the subsequent huge American herds of *criollo* cattle descended from these few ancestors." Cattle were introduced to the mainland in the 1520's, at Veracruz, Mexico (Jordan 1993:88). The first cattle in what is now the Southwestern United States arrived in New Mexico in 1598, with a party of colonists led by Juan de Oñate. The first cattle were not established in the former Hohokam region until 1697 at San Xavier del Bac, a result of Eusebio Francisco Kino's work (Jordan 1993:141).

Coyote. There is a long tradition of coyote stories in the folklore of Native Americans, including the O'odham (Leydet 1977:70-93). There is no evidence of coyote remains at Hohokam sites mentioned in the literature, and the coyote probably was not a resource. Other cultures have used coyote skins in special ceremonies, and coyote bones have been found at a Pueblo site (Leydet 1977: 85-86). Either coyotes or domestic dogs are depicted in Hohokam rock art (Wallace 1991:62). The long tradition of coyote folklore probably extended into prehistory.

Horses. The horse was unknown to the Hohokam or any other Native American group until Columbus arrived. Columbus carried the first domestic horses to the New World on his second voyage. Ironically, the horse originally evolved in what is now Western North America, but was extinct here some 8000 years before Columbus arrived (Ryden 1990:20-21). According to Ryden (1971:98), "paleontologists believe that North America was the ancestral home of the genus *Equus*. Early forms of the animal probably reached Asia across the Bering Land Bridge. All of today's domestic, feral or "wild" horses are descendants of these migrants. Today's horses came to the New World with the Spaniards."

How did horses become extinct in North America? Scientists are not sure. One controversial hypothesis, according to archaeologist P. S. Martin (quoted in Ryden 1990:21) holds that "the principal factor isolated as cause is the appearance of man." Ryden (1991:21) writes that "a brief two thousand years after the appearance of man in North America, horses and camels were extinct. Their charred bones, along with hunting and butchering tools, have been unearthed from remains of prehistoric cooking sites." No other documentation for this hypothesis was found in the literature.

Some mistakenly assume that the federally protected "wild" horses that roam the American West are native animals. These horses are all feral descendants of domestic horses, imported to North America from the Old World.

Javelina, or collared peccary, superficially resembles a domestic pig but is classified in a separate family, the *Tayassuidae*. Domestic pigs, wild boar, bush pigs, and warthogs are all in the family *Suidae,* and they are only distantly related to the collared peccary. Gallizioli (1979:18) writes that "a domestic tabby has closer ties to an African lion than does the javelina to the domestic swine."

Javelinas are common in the southwestern United States today but were unknown to the Hohokam. Cohn (1997:30) writes that "no bones, relics, or art evidence has been found among [Native American] archaeological sites that date before 1700. The first reports of javelinas date from 19th century trappers who wrote about 'river hogs.'" Researchers believe that the javelina, primarily a rainforest

animal, migrated into the Sonoran Desert of Arizona from northern Mexico by following rivers during the 1800's.

6
Diseases

T. M. Fink proposed that Hohokam canals and reservoirs may have transmitted infectious diseases (Doyel 1991: 267), but most of what we know about the physical health of the Hohokam comes from studies of their bones. According to Charles Merbs (1985:127), studying Hohokam skeletal remains has been problematic for several reasons. Most obvious is the Hohokam practice of cremation. After cremation, the Hohokam often further broke bones into unrecognizable fragments. Commonly, early archaeologists or non-professionals lost or improperly preserved bones. Today, according to Merbs (1985:139), a few archaeologists present their studies of human bones at scientific meetings, but the results are seldom published.

Merbs (1985:127) reviewed documents published by Dr. Washington Matthews, an army surgeon with the Hemenway expedition of 1891. Matthews found a high occurrence of congenital spine defects. Matthews diagnosed a mild case of rickets in one individual, although no other Hohokam skeletons show signs of rickets. Matthews attributed the deformities to malnutrition. Haury (1976:114) suggests that evidence from Snaketown excavations indicate that the Hohokam diet may have suffered seriously from protein deficiency.

In other parts of the Southwest, skeletons of Hohokam infants and children have shown evidence of iron deficiency anemia. Diets consisting primarily of corn are sometimes deficient in iron, but anemia can also indicate intestinal parasites. Other skeletons showed signs of either valley fever (coccidioidomycosis, a fungal disease) or possibly tuberculosis (a bacterial disease). Valley fever affects both humans and canines. Merbs suggests that if valley fever were present among the Hohokam, their domestic dogs would also be affected. Investigators have not found prehistoric dog bones showing signs of valley fever at Hohokam sites, so the question remains unanswered.

Birkby (1976:383) found at least five cases indicative of osteoarthritis. Deformed teeth and dental caries were also common. Close to 70% of all Hohokam skeletons examined by Matthews had dental caries. Matthews compared the skeletons to those of five other Native American groups and found the Hohokam to be "by far the most carious" (Merbs 1985:138)."

7
Changes in the Landscape

What Happened to the Hohokam?

Professionals and amateurs have all proposed theories to explain the "abandonment" or "disappearance" of the Hohokam. The terms "abandonment" and "disappearance" are misleading, but we do know that "a significant population reduction occurred between AD 1400 and 1700 (Doyel 1991a:267)." Cordell (1984:304) categorizes the many hypotheses to explain the changes into two categories: cultural explanations and environmental explanations. Cultural explanations, she explains, include "warfare, factionalism, and disruption of trade contacts with Mesoamerica," which will not be discussed here. Did environmental factors play a role in the decline of the Hohokam?

Cordell (1984:323) cites several researchers who suggest that "some form of environmental instability that was not readily compensated for through the traditional Hohokam irrigation systems taxed the subsistence base [and caused political reorganization] in the 1100's." Although Cordell (1984:324) adds that "there is not sufficient evidence of environmental change in the Hohokam area" and Masse (1991:218) writes that "the collapse . . .has no clear-cut environmental correlate . . .," this section will focus on environmental explanations: soil salinization, disease, and floods.

Soil Salinization. Cordell (1984:324) notes two observances relating to the environment: (1) increased use of upland slopes for gathering and processing wild plants, and (2) an increase in the growth of possibly salt tolerant native barley. Both of these observations may point to salinization of irrigated Hohokam fields, but they do not adequately explain widespread changes that occurred. As Haury (1976:355) points out, communities not dependent on canal irrigation were also affected.

Disease. Fink (quoted in Doyel 1991a:267) suggests that canals may have transmitted infectious diseases. There is little evidence to support the idea of an epidemic, but if it had occurred it could have devastated the densely populated communities along the rivers. Some researchers have attempted to extend the Hohokam time frame beyond 1450 to show that they met their demise through introduced European diseases in the 16th century. According to Doyel (1991a:266) there is no evidence to support this claim. Doyel notes, however, that "carried up the trade routes from Mesoamerica after AD 1525. . .these new diseases may have further reduced the resident populations prior to the coming of the Spanish [into the Hohokam area in the late 1600's]."

Flooding. The Hohokam were skilled at controlling the rivers to irrigate their fields, but could they respond to unusual changes in the rivers? Studies of Salt River flow patterns based on tree-ring data, geological research, and historical climatology by Nials, Gregory, and Graybill; Partridge and Baker; and Fuller (quoted in Doyel 1991a:234), indicate that "serious problems due to increased river flow levels may have occurred on at least eight occasions of sufficient strength to damage head gates, wash out canal banks, and alter the flow of water in the riverbed. They further propose that flows at AD 899 and 1352 had devastating effects, resulting in system disuse, abandonment, and population relocation."

Two "disastrous" floods occurred in the 1300's that may have destroyed canal systems (Wilcox 1991: 59). The Hohokam were incredibly successful irrigationists, but perhaps they could not control the rivers during extreme fluctuations. Masse (1991: 219) writes that "the destruction of irrigation systems is not sufficient by itself to explain abandonment [or relocation by the Hohokam]."

Most researchers agree that rather than disappearing from or abandoning the area, "it now appears that by 1400 AD, the resident populations returned to less complex architectural, settlement, and economic patterns" (Doyel 1991a:266).

The Hohokam Landscape Today

If the Hohokam were to travel through time to the present day, they would recognize the cotton, corn, and barley that still grow in the Salt and Gila valleys, although the varieties are different. They would recognize the irrigation canals, although they also appear different from Hohokam canals. The modern canals are often lined with concrete and are fed by means of diversion dams instead of leading directly from the river.

The Hohokam would notice the dry riverbed and the missing riparian forest, along with the many varieties of plants, birds, mammals, fish, insects, and other creatures that were a part of their everyday life. Six or seven species of native fishes are extinct, and others, including the Colorado Squawfish, are threatened or endangered.

The Hohokam might also notice new elements in the environment: exotic species have replaced native flora. Tamarisk, a Eurasian invader, has exploded along the Gila and Salt channels and replaced the native trees (Rea 1983:30). There has also been a change in the distribution of native plants. For example, the decline of the mesquite around Casa Grande Ruins has created a favorable environment for creosote-bush to move in (Clemensen 1992:159). The mesquite bosques that provided a reliable source of food for the Hohokam and forage for hunted animals are mere skeletons and stumps in many places.

A Hohokam visitor to late 20th century Sonoran Desert might notice a change in the animal population as well as the plant population. Starlings first arrived in Arizona in 1946, and may now compete with other hole nesting species such as woodpeckers (Rea 1983:219). Agricultural spraying of insecticides in cotton fields reduced the population of native insects, and consequently the population of bats (Clemensen 1992:163). Until the mid 1940's, bats lived in the Casa Grande and attracted the red and black racer snakes who ate them. With the disappearance of the bats, the snake population has also declined (Clemensen 1992:164).

The insecticides affected birds as well. The number of cactus wrens has decreased around Casa Grande Ruins since the 1960's, and so has the population of owls. Large populations of sparrows have moved into the Casa Grande ruin (Clemensen 1992:164). In recent discussions with Casa Grande staff, they expressed concern over the damage that large numbers of pigeons might cause to the prehistoric building. Fewer large mammals, such as coyotes, are seen today around the Monument (Clemensen 1992:161) perhaps contributing to the explosion in the Roundtail ground squirrel population.

Probably the most striking change that time-traveling Hohokam would note would be the structures built by modern humans. Even around the Casa Grande Ruins National Monument, trailer parks, shopping malls, and houses have replaced agricultural fields.

This paper has been an attempt to provide scientifically based information about the Hohokam and their environment, but many questions cannot be left to science. These questions are left for interpreters and visitors to ponder for themselves.

APPENDIX I

Some Plants Associated with the Hohokam

(Gasser and Kwiatkowski 1991; Bohrer 1991; Wilcox and Shenk 1977; and others)

Common Name	*Scientific Name*
Agave	*A. murpheyi* Gibson, *Agave* spp.
Amaranth	*Amaranthus* sp.
Bottle Gourd	*Lagenaria siceraria* Standl.
Bristle Grass	*Setaria* sp.
Brome Grass	*Bromus* sp.
Canary Grass	*Phalaris caroliniana* Walt.
Catclaw Acacia	*Acacia greggii* Gray
Cattail	*Typha* sp.
Cheno-am	*Chenopodiaceae or Amaranthus sp.*
Cholla	*Opuntia* sp.
Common Bean	*Phaseolus vulgaris* Savi.
Cotton	*Gossypium hirsutum var. punctatum* Linnaeus
Cottonwood	*Populus fremontii* Wats.
Creosote-bush	*Larrea tridentata* DC.
Domestic Grain Amaranth	*Amaranthus hypochondriacus* Rob.
Douglas-Fir	*Pseudotsuga menziesii* Mirbel
Dropseed	*Sporabolus* sp.
Globemallow	*Sphaeralcea* sp.
Goosefoot	*Chenopodium* sp.
Guayule	*Parthenium argentatum* Gray
Hedgehog Cactus	*Echinocereus* sp.
Horse Purslane	*Trianthema portulacastrum* Linnaeus
Ironwood	*Olneya tesota* Gray
Jack Bean	*Canavalia ensiformis* DC.
Juniper	*Juniperus* sp.
Lima Bean	*Phaseolus lunatus* Linnaeus
Little Barley	*Hordeum pussilum* Nutt.
Locoweed	*Astragalus* sp.
Maize, corn	*Zea mays* Linnaeus
Mesquite	*Prosopis* spp.
Monolepis	*Monolepis* sp.
Ocotillo	*Fouquieria splendens* Gray
Palo Verde	*Cercidium* spp.
Panic Grass	*Panicum* sp.
Pines	*Pinus ponderosa* Lawson, *Pinus spp.*
Plantain	*Plantago* sp.
Potato Family	*Solanaceae*
Prickly Pear	*Opuntia* sp.
Purslane	*Portulaca* sp.
Red Dye Amaranth	*Amaranthus cruentus* Linnaeus
Saguaro	*Carnegiea gigantea* Engelm.
Sand Root	*Ammobroma sonorae* Torr.
Scarlet Runner Bean	*Phaseolus coccineus* Linnaeus
Seepweed	*Suaeda* sp.
Squash	*Cucurbita* sp.
Stick-leaf	*Mentzelia* sp.
Tansy Mustard	*Descurainia* sp.
Tepary Bean	*Phaseolus acutifolius* var. *latifolius* Gray
Tobacco	*Nicotiana* sp.
White Fir	*Abies concolor* (Gordon and Glendinning)
White-seeded Devil's Claw	*Proboscidea parviflora* var. *hohokamia* (Wooten)
Wild Chili Pepper	*Capsicum* sp.
Wild Gourd	*Cucurbita* sp.
Wild Lily	*Allium* sp.
Yucca	*Yucca* spp.

APPENDIX II

Some Animals Associated with the Hohokam

(Greene and Mathews 1976; McKusick 1976; Olsen 1976; Minckley 1976; Szuter 1991; Gasser and Kwiatkowski 1991; Rea 1983; Haury 1976, and others)

Common Name	*Scientific Name*
MAMMALS	
Antelope jackrabbit	*Lepus alleni* Meams
Badger	*Taxidea taxus* Baird
Bighorn Sheep	*Ovis canadensis* Merriam
Blacktail jackrabbit	*Lepus californicus* Meams
Cottontail rabbit	*Sylvilagus auduboni* Mearns
Coyote	*Canis latrans* Merriam
Domestic dog	*Canis familiaris* Linnaeus
Kit Fox	*Vulpes macrotis* Merriam
Mule Deer	*Odocoileus hemionus* Meams
Muskrat	*Ondatra zibethicus* Baird
Packrat	*Neotoma* spp.
Pronghorn Antelope	*Antilocapra americana* Merriam
Roundtail Ground Squirrel	*Spermophilus tereticaudus* Baird
Spotted Ground Squirrel	*Spermophilus spilosoma* Merriam
BIRDS	
American Avocet	*Recurvirostre americana* Gmelin
American Kestral (Sparrow Hawk)	*Branta canadensis* Branta
Canada Goose	
Coopers Hawk	*Accipiter cooperii* Bonaparte
Dark-eyed Junco	*Junco hyemalis* Linnaeus
Lesser Scaup	*Aythya affinis* Eyton
Gambel's Quail	*Callipepla gambelii* Gambel
Gilded Flicker	*Colaptes auratus* Linnaeus
Great Blue Heron	*Ardea herodias* Linnaeus
Green-winged Teal	*Anas crecca* Linnaeus
Hooded Oriole	*Icterus cucullatus* Swainson
Mallard Duck	*Anas platyrhynchos* Linnaeus
Marsh Hawk	*Circus cyaneus* Linnaeus
Meadowlark	*Sturnella sp.*
	Falco sparvarius Linnaeus
Northern Cardinal	*Cardinalis cardinalis* Linnaeus
Pintail Duck	*Anas acuta* Linnaeus
Raven	*Corvus corax* Linnaeus
Red-winged Blackbird	*Agelaius phoenecius* Linnaeus
Roadrunner	*Geococcyx californianus* Lesson
Sandhill Crane	*Grus canadensis* Linnaeus
Scarlet Macaw	*Ara macao* Linnaeus
Scrub Jay	*Aphelocoma coerulescens* Bosc.
Snow Goose	*Chen hyperborea* Linnaeus
Ruddy Duck	*Oxyura jamaicensis* Gmelin
Thick-billed Parrot	*Rhynchopsitta pachyrhyncha* Swainson
Turkey	*Meleagris gallopavo* Linnaeus
White-fronted goose	*Anser albifrons* Scopoli
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus* Bonaparte
REPTILES	
Gila Monster	*Heloderma suspectum* Cope
Horned Lizard	*Phrynosoma* spp.
Turtle	*Kinosternon* sp.
FISHES	
Roundtail chub	*Gila robusta* Baird and Girard
Colorado Squawfish	*Ptychocheilus lucius* Girard
Sonoran Suckers	*Catostomus insignis* Baird and Girard
Desert Sucker	*Pantosteus clarki* (Baird and Girard)
Marine Drum or Croaker	*Cynoscion* sp.
Razorback sucker	*Xyrauchen texanus* (Abbott)
ARTHROPODS	
Cochineal Insect	*Dactylopius* spp.
Corn earworm/Cotton bollworm	*Heliothus* sp.
Marine swimming crab	*Callinectes bellicosus* Stimpson
MOLLUSKS	
Basket whelks	*Nassarius iodes* Dall
Bittersweet shell	*Glycymeris gigantea* Reeve
Bittersweet shell	*Glycymeris maculata* Broderip
Cerith	*Cerithium* sp.
Cockle shell	*Laevicardium elatum* Sowerby
Coffee Bean shell	*Trivia solandri* Sowerby
Cone shell	*Conus* sp.
Cowries	*Cypraea annettae* Dall
Horn shell	*Cerithidea* sp.
Nerites	*Nerita scabricosta* Lamarck
Olive shell	*Olivella* sp.
Spiny Oyster	*Spondylus* sp.
Tower shell	*Turritella* spp.
Venus clams	*Dosinia* sp.
Whelk	*Anachis* sp.
Worm shells	*Vermetus* sp.
No common name	*Amnicola* sp.
No common name	*Anadonta* sp.
No common name	*Argaronia* sp.
No common name	*Catinella* sp.
No common name	*Gastrocopta* sp.
No common name	*Haliotis* sp.
No common name	*Helisoma* sp.

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